A POLYCLAVE TO THE MONOCOTYLEDONOUS FAMILIES OF THE WORLD

A Computer Generated Identification Key

C. Kameswara Rao

Department of Botany
Bangalore University, Bangalore, India

R. J. Pankhurst

Department of Botany
British Museum (Natural History)
London, England

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We welcome any suggestions and comments for the improvement of the key.

British Museum (Natural History)
London
July 1984

C. Kameswara Rao
R. J. Pankhurst

INTRODUCTION

Since Lamarck's *Flore Françoise* (1778), the dichotmous key has stood the test of time and served as the most important device for biological identification. Nevertheless, such keys with a single-access potential have several shortcomings. The user has to enter (use) the key in the same sequence as the author of the key dictates; incomplete material often makes it difficult to use the key and may even hamper the process of identification. Only very little variation and few exceptions, if at all, can be incorporated in the dichotmous key. Dichotmous keys, particularly to large groups of taxa, are often too lengthy, confusing, tedious and time-consuming. The need for more efficient devices for identification soon became evident, although not much was done for a very long time.

Davis (1972) has introduced a formula key with a limited multi-access potential. But the card overlay systems (termed Polyclaves by Duke, 1969) have a much greater latitude in terms of access potential, although even in these only one character can be used at a time (monothetic). Polyclaves are not merely devices for identification; they also serve as data bases.

There are two kinds of card overlay systems: the edge-punched and the body-punched (see Pankhurst, 1975, for details). A key to the identification of wood samples (Phillips, 1948) and one to pollen compiled at the French Institute, Pondicherry (Thanikaimoni, unpublished), are among the few botanical examples of the edge-punched card systems. Hansen & Rahn (1969) published a body-punched card key to the angiosperm families and Duke (1969) prepared a polycalve (of a different format) for the flowering plant families including gymnosperms. Large-scale mechanical reproduction of all these keys was difficult. The keys of Hansen & Rahn (1969) and Duke (1969) were mainly based upon family descriptions and so could not account for much variation and exceptional states. Besides, the range and combinations of characters/states required to identify dicotyledonous and monocotyledonous families are not the same. Dealing with both of them (and gymnosperms) together in the same polyclave has obvious disadvantages. These limitations resulted in failure rates higher than anticipated.

Polyclaves on computer cards are compact and convenient; the use of a computer for their mass mechanical reproduction has improved the situation. Simpson and Janos (1974) and Saldanha & Kameswara Rao (1975) used computers to a limited extent while Barnett and Pankhurst (1974) have utilised the computer potential to a far greater degree. The advantage of these keys is that the computer was required only at the production stage and not at the user's level.

The development of computer programs that can automatically generate a polyclave from a data base has introduced a new dimension to key construction (see Pankhurst, 1975, for details).

Most floras include dichotomous keys to the monocotyledonous families occurring only in the geographic areas covered by them. Several dichotomous keys that also deal with the monocotyledonous families, but with varying degrees of geographic coverages, have been published; e.g. Davis & Cullen (1979): north temperate regions; Geesink *et al.,* (1981): generally world wide but particularly Europe and south east Asia; Hutchinson (1967): world wide. There have been only two polyclaves that dealt with the monocotyledonous families (Duke, 1969; Hansen & Rahn, 1969); both include dicotyledonous families as well. The shortcomings of all these have already been discussed above. Against this background, it was considered that a comprehensive polyclave, with world wide coverage, exclusive to the monocotyledonous families, was worth producing.

The present polyclave represents the data base for 77 morphological characters and

geographical distribution (see Table 2) of the 69 monocotyledonous families as delimited by Hutchinson (1973). We used a program package often referred to as KEYGEN (Pankhurst, 1978) to prepare this polyclave. This program employs the potential of the computer to a very high degree. From the data base fed into it, the computer can:

1. automatically check some aspects of correctness of the data matrix,
2. draw complete descriptions of any or all taxa,
3. give information on the distribution of specific characters/states among the taxa covered,
4. print lists of pairs of taxa that cannot be distinguished on the basis of the existing data,
5. calculate the diagnostic power of characters and list them,
6. automatically generate a polyclave or a conventional diagnostic key,
7. allow specimen identification either directly using a terminal (on line identification) or by matching methods (based on computer calculated similarity coefficients), and
8. allow usage of clustering algorithms.

The data have now been converted into the DELTA format processed by the CONFOR program package (Dallwitz, 1980, 1984), as this format is more flexible and convenient to use. A program PANDEL has been developed to convert data from the KEYGEN format to the DELTA format (Pankhurst, 1984). The monocot data base in either format may be obtained from RJP for research purposes.

The information contained in the cards can be manually retrieved in several forms. In addition to being used as an identification device, this polyclave can also serve as a teaching aid. From the data stored in the cards, one can answer questions such as:

1. What is the distribution of a particular character/state in the monocots or what families occur in a particular geographical area? (study the relevant cards);
2. What character states occur in a particular family? (study those cards with holes for the family);
3. What are the diagnostic states between certain allied families? (collect all cards with holes for the relevant families and separate out the ones with holes common to them; the rest are the diagnostic states).

While preparing the data base and the key we had a wide range of users in mind and strove for greater information content and ease of judgement of character states—two essential prerequisites for the success of a polyclave.

The most important step in successful plant utilisation for human welfare lies in the correct identification of taxa. Currently this basic and important need is not adequately served outside specialist institutions. Production of easily usable keys with various taxonomic and geographic coverages and making them readily accessible to the general user will go a long way. Ours is a very small step in this direction. We hope that this polyclave will generate a greater interest in the production of similar data bases and keys.

THE FAMILIES

Sixty-nine monocot families as delimited by Hutchinson (1973) were adopted for this polyclave. This does not imply advocating the phylogenetic concepts or family sequences therein, more so as this polyclave is mainly meant to be a device for identification of monocot families. The generic keys provided by Hutchinson helped in finding out the placement of genera in the respective families and highlighted their diagnostic features as well.

In recent years a large number of small families have been recognised, presumably to make taxa more homogenous (see Appendix II). These families were delimited on the basis of characters which are outside the scope of this key (e.g., anatomical, palynological, developmental, etc.). Even if these families were treated as distinct by us in the polyclave,

they would still key out along with their former inclusive families, so that their recognition would serve no real purpose.

A list of the families in the polyclave (along with their respective punch positions on the cards, their serial number in Hutchinson's system (1973) and the families, if any, submersed in them) is given in Table 1. An alphabetical list of the families and their punch positions is given in Appendix III. A summary of the differences between Hutchinson's system and those of Bentham & Hooker (1883), Melchior (Engler's) (1964), Takhtajan (1980), Cronquist (1981), Dahlgren & Clifford (1982) and Dahlgren & Rasmussen (1983) is given in Appendix II.

TABLE 1

Families in the polyclave

The respective positions in the cards (column 1), the serial number of the family in Hutchinson's system (1973) (column 2), the name of the family and authority are given. The families included, if any, are shown in parenthesis.

ABBREVIATIONS: incl. = includes; p.p. = in part; nom. alt. = alternate name; orth. var. = different spelling.

11	343	BUTOMACEAE Richard (incl. Limnocharitaceae Takhtajan)
12	344	HYDROCHARITACEAE A. L. de Jussieu (incl. Elodeaceae Durmotier, Stratiotaceae Link; Vallisneriaceae Dumortier; Halophilaceae J. G. Agardh; Blyxaceae, Enhalaceae, Thalassiaceae—all Nakai)
13	345	ALISMATACEAE Ventenat (incl. Borboraceae Dulac p.p., Elismataceae Nakai)
14	346	SCHEUCHZERIACEAE Rudolphi (incl. Borboraceae Dulac p.p.)
15	347	PETROSAVIACEAE Hutchinson (incl. Miyoshiaceae, Protoliriaceae—both Makino)
16	348	TRIURIDACEAE Gardner
17	349	JUNCAGINACEAE Richard (incl. Triglochinaceae Dumortier; Borboraceae Dulac p.p.; Maundiaceae Nakai)
18	350	LILAEACEAE Dumortier (nom. alt. Heterostylaceae Hutchinson)
19	351	POSIDONIACEAE Lotsy
20	352	APONOGETONACEAE Planchon
21	353	ZOSTERACEAE Dumortier
22	354	POTAMOGETONACEAE Dumortier (incl. Hydrogetonaceae Link)
23	355	RUPPIACEAE Hutchinson
24	356	ZANNICHELLIACEAE Dumortier (incl. Cymodoceae Taylor)
25	357	NAJADACEAE A. L. de Jussieu (orth. var. Naiadaceae)
26	358	COMMELINACEAE R. Brown
27	359	CARTONEMATACEAE Pichon
28	360	FLAGELLARIACEAE Dumortier (incl. Joinvilleaceae A. C. Smith & Tomlinson; Hanguanaceae Airy-Shaw)
29	361	MAYACACEAE Kunth
30	362	XYRIDACEAE C. A. Agardh (incl. Abolbodaceae Nakai)
31	363	RAPATEACEAE Dumortier
32	364	ERIOCAULACEAE Desvaux
33	365	BROMELIACEAE A. L. de Jussieu (incl. Tillandsiaceae A. de Jussieu)
34	366	MUSACEAE A. L. de Jussieu
35	367	STRELITZIACEAE Hutchinson (incl. Heliconiaceae Nakai)
36	368	LOWIACEAE Ridley (incl. Orchidanthaceae Dostál)
37	369	ZINGIBERACEAE Lindley (incl. Drymyrrhizae Ventenat; Amomeae Richard; Curcumaceae Dumortier; Alpiniaceae Small; Costaceae Nakai)
38	370	CANNACEAE A. L. de Jussieu
39	371	MARANTACEAE Lindley

continued

Table 1 – *continued*

40	372	LILIACEAE A. L. de Jussieu (incl. Asparagaceae, Asphodelaceae—both A. L. de Jussieu; Colchicaceae A. P. de Candolle; Hemerocallidaceae, Melanthiaceae—both R. Brown; Veratraceae C. A. Agardh; Asteliaceae, Dasypogonaceae, Calochortaceae—all Dumortier; Convallariaceae, Funkiaceae, Tulipaceae, Composomaceae—all Horaninow; Aphyllantheae Burnett, Eriospermaceae, Herreriaceae, Aspidistraceae, Ophiopogonaceae —all Endlicher; Uvulariaceae Kunth; Aloaceae, Abamaceae, Antheriaceae, Hyacinthaceae, Helionadaceae—all J. G. Agardh; Cymbanthaceae, Eucomidaceae, Peliosanthaceae, Themidaceae, Ornithogalaceae, Polygonataceae, Platymetraceae, Dianellaceae, Bulbocodiaceae, Lachenaliaceae, Fritillariaceae—all Salisbury; Eucommiaceae van Tieghem; Johnsoniaceae, Scillaceae—both Lotsy; Nartheciaceae Small)
41	373	TECOPHILAEACEAE Leybold (incl. Cyanellaceae Salisbury; Cyanastraceae Engler)
42	374	TRILLIACEAE Lindley (incl. Paridaceae Dumortier)
43	375	PONTEDERIACEAE Kunth (incl. Heterantheraceae J. G. Agardh)
44	376	SMILACACEAE Ventenat (incl. Sarmentaceae Sonnenburg)
45	377	RUSCACEAE Sprengel
46	378	ALSTROEMERIACEAE Dumortier
47	379	PETERMANNIACEAE Hutchinson
48	380	PHILESIACEAE Dumortier (incl. Lapageriaceae Kunth; Luzuriagaceae Dostál)
49	381	ARACEAE A. L. de Jussieu (incl. Acoraceae C. A. Agardh; Pistiaceae Dumortier; Callaceae, Orontiaceae—both Bartling; Cryptocorynaceae J. G. Agardh; Caladiaceae, Dracontiaceae—both Salisbury; Spadicaceae Dulac)
50	382	LEMNACEAE S. F. Gray (incl. Wolffiaceae Nakai)
51	383	SPARGANIACEAE C. H. Schultz
52	384	TYPHACEAE A. L. de Jussieu
53	385	AMARYLLIDACEAE J. St Hilaire (incl. Narcissaceae A.L.Jussieu; Gilliesiaceae Lindley; Leucojaceae Dumortier; Brunsvigiaceae, Pancratiaceae—both Horaninow; Gethyllidaceae, Alliaceae—both J. G. Agardh; Cepaceae, Cyrtanthaceae, Galanthaceae, Haemanthaceae, Oporanthaceae, Sturmariaceae, Tulbaghiaceae, Zephryanthaceae—all Salisbury; Bractillaceae Dulac; Agapanthaceae Lotsy; Ixiolirionaceae, Lophiolaceae—both Nakai)
54	386	IRIDACEAE A. L. de Jussieu (incl. Ixiaceae Horaninow; Ensateae Ker-Gawler; Gladiolaceae Salisbury; Spathaceae Dulac; Isophysidaceae Takhtajan; Hewardiaceae Nakai)
55	387	STENOMERIDACEAE J. G. Agardh
56	388	TRICHOPODACEAE Hutchinson
57	389	ROXBURGHIACEAE Wallich (incl. Stemonaceae Franchet & Savat; Croomiaceae Nakai)
58	390	DIOSCOREACEAE R. Brown (incl. Tamaceae S. F. Gray; Androsynaceae Salisbury; Cladophyllaceae Dulac)
59	391	XANTHORRHOEACEAE Dumortier (incl. Dasypogonaceae Dumortier, Calectasiaceae, Xerotaceae, Kingiaceae—all Endlicher; Lomandraceae Lotsy)
60	392	AGAVACEAE Endlicher (incl. Yuccaceae, Phormiaceae—both J. G. Agardh; Dracaenaceae Salisbury; Sansevieriaceae, Nolinaceae—both Nakai)
61	393	ARECACEAE C. H. Schulz (nom. alt. Palmae; incl. Cocosaceae, Coryphaceae, Phoenicaceae, Sabalaceae, Sagaceae—all C. H. Schultz; Phytelephantaceae Martius, Aristaceae, Borassaceae, Caryotaceae, Ceroxylaceae, Chamaedoraceae, Geonomaceae, Iriarteaceae, Lepidocaryaceae, Malortieaceae, Manicariaceae, Pseudopheonicaceae—all O. F. Cook; Nipaceae Chadefond & Emberger)
62	394	PANDANACEAE R. Brown
63	395	CYCLANTHACEAE Dumortier
64	396	HAEMODORACEAE R. Brown
65	397	HYPOXIDACEAE R. Brown (incl. Campynemataceae, Xiphidiaceae—both Dumortier)
66	398	VELLOZIACEAE Endlicher
67	399	APOSTASIACEAE Blume
68	400	TACCACEAE Dumortier
69	401	PHILYDRACEAE Link

70	402	BURMANNIACEAE Blume (incl. Tripterellaceae Dumortier; Geosiridaceae Jonker*)
71	403	THISMIACEAE J. G. Agardh
72	404	CORSIACEAE Beccari (incl. Arachnitidaceae C. Munoz; Achratinitaceae Barkely & Airy-Shaw)
73	405	ORCHIDACEAE A. L. de Jussieu (incl. Cyprepediaceae Lindley; Neottiaceae Horaninow; Vanillaceae Lindley; Limodoraceae Horaninow; Thyridiaceae Dulac)
74	406	JUNCACEAE A. L. de Jussieu (incl. Sexglumaceae Dulac)
75	407	THURNIACEAE Engler
76	408	CENTROLEPIDACEAE Endlicher (incl. Desvauxiaceae Dumortier; Hydatellaceae Hamann—Hamann recognised Hydatellaceae in 1976 but the two genera *Juncella* and *Hydatella* were included by Hutchinson in the genus *Trithuria* of the Centrolepidaceae)
77	409	RESTIONACEAE R. Brown (incl. Anarthriaceae, Ecdeiocoleaceae—both Cutler & Airy-Shaw)
78	410	CYPERACEAE A. L. de Jussieu (incl. Caricaceae, Scirpaceae, Papyraceae—all Burnett; Lepistichaceae Dulac; Kobresiaceae Gilly)
79	411	POACEAE Barnhart (nom. alt. Gramineae; incl. Agrostidaceae, Avenaceae, Bambusaceae, Hordeaceae, Miliaceae, Oryzaceae, Phalaridaceae, Saccharaceae, Spartinaceae, Stipaceae—all Burnett; Graminaceae Lindley; Andropogonaceae, Panicaceae, Chloridaceae, Eragrostidaceae, Lepturaceae, Sporobolaceae, Arundinellaceae, Festucaceae—all Herter; Anomochloaceae, Parianaceae, Streptochaetaceae—all Nakai)

*Hutchinson discussed *Geosiris* in the Burmanniaceae without committing on the familial status or the inclusion of the genus in the Burmanniaceae.

FORMAT OF THE CARDS

This polyclave consists of a pack of standard 80-column punched computer cards. Each card has numbers printed in 10 rows (0—9; horizontal) and 80 columns (1 to 80; vertical). Row numbers are printed all over the card and column numbers only across the top and bottom edges (see Text Fig. 1). The cut corner at the top helps to align the cards properly. The punch positions of the families are grouped to the left (columns 1 to 7). The character state which the card represents and its serial number are printed along the top of the card. Punches from column 21 and onwards have nothing to do with the families and data; they only serve as a machine code for printing the details at the top of the card.

Each card represents one character state (e.g.: leaves absent, anthers appendaged); there are at least two states for each character. The 235 cards in the pack thus represents as many states of 77 characters. The serial numbers of the cards will help in keeping the cards in order. These numbers are in four figures—the first two representing the number of the character and the last two the number of the state. Thus, card 0904 refers to character 9, state 4; 2801 refers to character 28, state 1; 7711 refers to character 77, state 11.

DATA IN THE CARDS

If there is a rectangular hole in the position assigned to a particular family (see Table 1), it means that the character state represented by that card occurs in that family. Absence of a hole means that the state in question was not found in the taxon. All the holes in columns 1 to 7 in any card in the set thus represent families in which the relevant character state occurs. Although the negative states are recorded in separate cards in certain cases, both the holes and non-holes put together form the data matrix of the character state represented by a particular card. If a family is variable for a character, all the relevant cards have holes punched in the corresponding position. Variation in the occurrence of different states of a character in a particular family can be found by examining the respective cards.

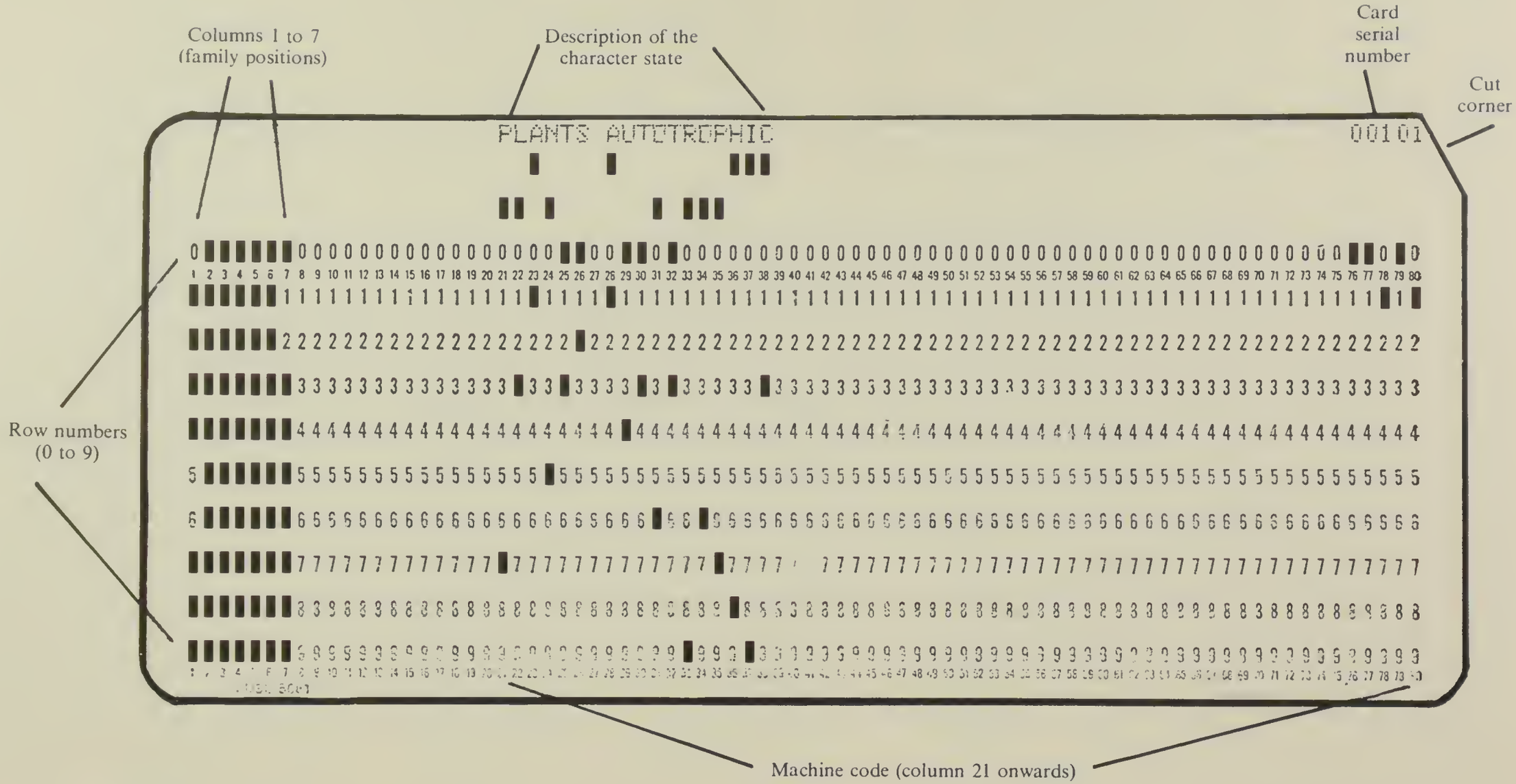

Fig. 1 A card from the polyclave

READING THE FAMILY POSITIONS ON THE CARDS

Each of the 69 families is assigned a specific punch position that is constant for that family throughout the set. Family positions are read along the vertical (columns 1 to 7) and horizontal (rows 0 to 9) coordinates. For obvious reasons row 0 in column 1 is not used. Consequently, the first family (Butomaceae) was given the code number 11 (instead of 01) and the last family (Poaceae) 79 (instead of 69). Family number 11 means column 1, row 1; 20 means column 2, row 0; 69 means column 6, row 9; and so on (see Table 1).

CHARACTERS AND THEIR STATES

Only easily observable morphological characters were used in this polyclave (see Table 2). Since the key is meant to be a field device for the identication of families, characters that may require laboratory facilities (e.g. anatomical, palynological) were avoided.

TABLE 2

List of characters and their states

The first line in each item gives the number of the character, number of states in the character and character description. Each of the remaining lines refers to the number of the character state and its description. The meaning of the terms is given in the illustrated glossary (Appendix I) and the Figure numbers below refer to the illustrations therein.

SYMBOLS *: see Notes on Characters (Table 7); C: conditional state; D, DD or DDD: dependent character state (see p. 19 & Table 6).

---

01 2Plants/nutrition
1 Autotrophic
2 Saprophytic

02 2Plants/herb or woody
1 Herbaceous
2 Arborescent*

03 3Plants/habit
1 Erect
2 Climbing or straggling
3 Supported by water*

04 4Plants/habitat
1 Terrestrial
2 Epiphytic or semiepiphytic
3 Aquatic or semiaquatic
4 of Saline habitat*

05 2Roots/type
1 Fibrous
2 Tuberous

06 2Root velamen/presence
1 Absent
2 Present

07 4Stem type
1 Rhizome C
2 Not rhizome C
3 Aerial or underwater
4 Absent C

08 2Aerial stem/nature
1 Nodose D
2 Not nodose D

09 2Stem/branching
1 Unbranched* DDD
2 Branched* DDD

10 4Exudate/colour
1 Absent*
2 Colourless*
3 White, yellow or red*
4 Resinous*

11 4Hairs*/nature
1 Absent
2 Simple (Figs 1, 2)
3 Glandular or vesicular (Figs 3, 4)
4 Branched (Figs 5 to 9)

12 4/Special structures
1 No special structures*
2 Tendrils present
3 Spines or prickles present
4 Cladodes or phyllodes present

continued

Table 2 – *continued*

13 3Leaves/presence
1 Absent C
2 Reduced to sheaths or scaly C
3 Normal

14 3Leaves/distribution
1 Basally crowded* D
2 Terminally crowded* D
3 Uniformly distributed D

15 5Leaves/arrangement
1 Spiral* D (Figs 10, 11)
2 Alternate* D (Figs 10, 12)
3 Distichous D (Figs 10, 13)
4 Opposite or subopposite D (Fig 14)
5 Whorled D

16 2Leaf base/sheath
1 Not sheathing D C (Fig 14)
2 Sheathing D (Figs 15 to 18)

17 2Leaf sheath/nature
1 Open DDD (Fig. 17)
2 Closed DDD (Fig. 18)

18 3Leaves/ligules, stipules etc.
1 Squamulate, ligulate or pulvinate* DD (Figs 19 to 21)
2 Stipulate DD (Figs 22, 23)
3 Eligulate and estipulate* DD

19 2Leaves/stalk
1 Sessile DD (Fig. 16)
2 Petiolate DD (Figs 14, 15)

20 3Leaves/cut
1 Entire DD
2 Serrate or dentate DD
3 Divided or lobed DD

21 3Leaves/compound
1 Simple DD
2 Pinnately compound DD
3 Palmately compound DD

22 2Leaves/form
1 Ensiform* DD (Figs 24 to 27)
2 Not ensiform* DD

23 2Leaves/fleshy
1 Fleshy or terete DD
2 Not fleshy or terete DD

24 7Ptyxis
1 Flat-curved* DD (Figs 28, 29)
2 Conduplicate* DD (Fig. 30)
3 Explicative* DD (Fig. 31)
4 Plicate* DD (Fig. 32)
5 Conduplicate-plicate* DD (Fig. 33)
6 Involute* DD (Fig. 34)
7 Supervolute* DD (Fig. 35)

25 5Venation
1 Invisible DD
2 Parallel DD
3 Pinnate DD
4 Palmate DD
5 Reticulate DD

26 2Flowers/scape
1 Scapose
2 Not scapose

27 2Flowers/aggregation
1 Solitary C
2 In inflorescences

28 2Infl. bract/spathe
1 Spathaceous D
2 Not spathaceous D

29 3Infl. axis/presence
1 Absent D C
2 Herbaceous D
3 Thick* D

30 2Main axis of infl./continuity
1 Continuous throughout DD (Figs 36 to 40)
2 Not continuous throughout DD (Figs 41 to 44)

31 3Infl./branching
1 Unbranched DD (Figs 36 to 38, 44)
2 Branched once DD (Figs 39, 41)
3 Branched more than once DD (Figs 40, 42, 43)

32 2Flowers/distribution on infl.
1 Uniformly distributed D (Figs 36, 37, 39, 40, 42, 43)
2 Crowded D (Figs 38, 41, 44)

33 2Flowers/insertion on infl.
1 Borne singly D (Figs 36, 37, 39 to 43)
2 Fascicled D (Figs 38, 44)

34 3Floral bracts/presence
1 Absent
2 One
3 More than one

35 2Flowers/pedicel
1 Pedicellate (Fig. 36)

2 Sessile (Fig. 37)

36 4Plants/sex
1 With hermaphrodite flowers
2 Monoecious
3 Dioecious
4 Polygamous

37 2Flowers/symmetry
1 Actinomorphic
2 Zygomorphic or asymmetric

38 4Perianth/presence
1 Caducous, reduced or absent* C
2 Free
3 Basally connate
4 Tubular

39 2Perianth/petaloid
1 Not petaloid D
2 Petaloid D

40 2Perianth/conspicuous
1 Inconspicuous D
2 Conspicuous D

41 3Perianth/number of whorls
1 One whorl D
2 More than one whorl, homochlamydeous D
3 More than one whorl, heterochlamydeous D

42 5Perianth segments/number
1 One D
2 Two D
3 Three D
4 Four to six D
5 More than six D

43 2Corona/presence
1 Absent D
2 Present D

44 8Fertile stamens/number
1 One
2 Two
3 Three
4 Four
5 Five
6 Six
7 Seven to ten
8 More than ten

45 2Staminodes/presence
1 Absent
2 Present

46 2Stamens/adnation
1 Free from perianth D (Fig. 50)
2 Adnate to Perianth D (Figs. 45, 46)

47 2Anthers/filaments
1 Sessile or subsessile C (Figs. 46 to 49)
2 Filamented (Figs 45, 50, 51)

48 2Filaments/connation
1 Free D (Fig. 50)
2 Connate D (Figs 48, 51)

49 2Anthers/appendages
1 Not appendaged*
2 Appendaged* (Figs 52 to 59)

50 3Anthers/dehiscence
1 Longidehiscent (Figs 56, 57)
2 Transidehiscent (Fig. 59)
3 Poricidal C (Figs 60, 61)

51 4Anthers/orientation
1 Introrse D (Fig. 62)
2 Extrorse D (Fig. 63)
3 Latrorse D (Fig. 64)
4 Versatile*D (Figs 45, 50)

52 3Anthers/locules
1 Unilocular
2 Bilocular
3 Plurilocular

53 2Pistillodes/presence
1 Absent
2 Present

54 3Ovary/position
1 Superior (Figs 65 to 68)
2 Semisuperior (Fig. 69)
3 Inferior C (Fig. 70)

55 2Ovary/stipe
1 Not Stipitate* D
2 Stipitate* D (Figs 71 to 73)

56 2Ovaries per flower/number
1 One (Figs 74 to 81)
2 More than one (Figs 82, 83)

57 3Styles/presence
1 Absent (Fig. 81)
2 One or connate (Figs 77 to 80)
3 Free (Figs 75, 76, 84)

58 2Style or stigma/position
1 Eccentric (Figs 84, 85)
2 Terminal (Figs 74 to 83)

continued

Table 2 - *continued*

59 4Ovules per locule/number
1 Solitary
2 Two
3 Three to five
4 More than five

60 5Placentation/type
1 Axile (Figs 86, 87)
2 Parietal or superficial (Figs 88 to 92)
3 Apical (Figs 93, 94)
4 Basal (Figs 94 to 96)
5 Marginal (Figs 97 to 100)

61 2Floral nectaries/presence
1 Absent*
2 Present*

62 2Fruit/simple
1 Simple
2 Syncarpic

63 2Fruit/nature
1 Fleshy
2 Dry C

64 2Fruit/dehiscence
1 Indehiscent C
2 Dehiscent

65 2Fruit/sutures
1 One sutured or circumscissile D
2 More than one sutured D

66 2Perianth on fruit/persistence
1 Persistent D
2 Not persistent D

67 2Fruit/wings
1 Winged
2 Not winged

68 2Fruit/stones
1 With stones* D
2 Without stones* D

69 3Seeds per fruit/number
1 One
2 Two or three
3 More than three

70 6Seed/shape
1 Linear to fusiform
2 Ellipsoid or ovoid
3 Lenticular, hemispherical or globose
4 Cylindrical or oblong
5 Pyramidal or turbinate
6 Arcuoid, cochleate, reniform or conchiform*

71 5Seed/appendages
1 Beaked or tailed
2 Arillate or carunculate
3 Coronate or operculate
4 Winged
5 Without appendages*

72 2Seed/hairiness
1 Comose, glochidiate or pilose
2 Glabrous

73 4Seed/surface
1 Pitted, reticulate, rugulose or spirosculptate*
2 Costate or rimmed
3 Muricate, spinulose, tuberculate or verrucose
4 Surface smooth

74 5Seed/colour
1 Black or grey
2 Green, yellow or white
3 Red or Brown
4 Mottled
5 Lustrous

75 3Distribution/general
1 Only temperate* C
2 Only tropical* C
3 Both temperate and tropical

76 5Distribution/temperate (see Map)
1 Circumboreal* D
2 Atlantic North American* D
3 Tethyan* D
4 Eastern Asiatic* D
5 Antarctic* D

77 11Distribution/tropical (see Map)
1 Madrean* D
2 Neotropical* D
3 African* D
4 Cape* D
5 Madagascan* D
6 Indian* D
7 Indochinese* D
8 Malesian* D
9 Fiji-Polynesian* D
10 Neocaledonian* D
11 Australian* D

In the preparation of a polyclave it is very necessary to have definite information on the distribution of all character states used in all the taxa covered. Although we have used inadequate information when a character is of general importance (see p. 21), we were very much restricted in the choice of characters due to non-availability of uniform and complete information. Certain characters commonly used in keys were not used, as they represent redundancies. For example, ovary locule number is largely covered by types of placentation and so was not used.

Each character is represented in at least two states (e.g. Corona: absent or present). Some characters occur in more states (see Table 2). Each character state is represented by a separate card.

Although we have used standard technical terms commonly employed to describe the characters and their states, it is likely that they may not convey the same meaning to everyone. To indicate the specific sense in which they were used here, notes are provided on some characters (Table 6). Those characters/states for which notes are given are indicated by an asterisk (*) in the character list (Table 2) and on the cards as well. An illustrated glossary is given in Appendix I to help the less experienced.

DIAGNOSTIC CHARACTERS AND STATES

Certain characters, due to the manner of their distribution in a taxonomic group, generally help in producing a quicker identification. These are the diagnostic characters. Some character states are uncommon in a group; they also are diagnostic for particular taxa.

The diagnostic characters are more effective when used in combination with other diagnostic characters. They divide the taxa into two or more groups at the stage of their use, and in combination with others, quickly eliminate character combinations irrelevant to the specimen in hand. Because of this property they can form the principal leads in a dichotomous key. From a large data base such as the present one, it is difficult to select such characters manually because, taken singly, their various states are found in a large number of taxa in the group. The separating (diagnostic) power of a character is reflected in the number of pairs of taxa it can help to distinguish. The efficiency of a key is proportional to the number of diagnostic characters. Much depends, however, upon the number of states in a character, their distribution and the size of the group. Based on an algorithm developed by Pankhurst (1983), the computer calculated the diagnostic power of 72 characters in this polyclave as given in Table 3. The number of states in each character and the number of pairs of families it can distinguish out of the total possible 2346 pairs are also given. The diagnostic power of the characters as indicated in Table 3 is operative only when the respective characters are used singly at the beginning of an identification.

The diagnostic states (with limited distribution) can be recognised by examining the cards—the fewer the holes in a card, the rarer the state. When present, the uncommon states are very useful as they separate out smaller groups from a large one. It should be remembered that uncommon states are present only in a few genera or species of a family; they usually do not characterise the whole family. A list of 77 states (of 50 characters) that occur in 23 ($\frac{1}{3}$ of 69) or fewer families is given in Table 4, along with the number of families in which each occurs.

It is advisable to look for diagnostic characters and uncommon states in the specimen; if few or none are available, care must be taken in the choice of the remaining cards as they represent characters with a very wide range of variation and distribution, and so have poor diagnostic power.

TABLE 3

Diagnostic power of characters

Character number	Description	Number of states	Number of pairs distinguishable
60	Placentation	5	1048
44	Fertile stamens: number	8	845
54	Ovary position	3	831
59	Ovules per locule: number	4	759
38	Perianth: presence	4	674
69	Seeds per fruit: number	3	644
75	Distribution: general	3	599
41	Perianth: number of whorls	3	522
04	Plants: habitat	4	520
24	Ptyxis	7	467
19	Leaves: stalk	2	459
57	Styles: presence	3	449
11	Hairs: nature	4	424
40	Perianth: conspicuous	2	420
03	Plants: habit	3	408
16	Leaf base: sheath	2	396
56	Ovaries per flower: number	2	385
34	Floral bracts: presence	3	384
47	Anthers: filaments	2	376
36	Plants: sex	4	373
64	Fruit dehiscence	2	360
13	Leaves: presence	3	335
09	Stem branching	2	308
14	Leaves: distribution	3	308
37	Flowers: symmetry	2	308
46	Stamens: adnation	2	299
50	Anthers: dehiscence	3	293
70	Seed shape	6	280
15	Leaves: arrangement	5	277
32	Flowers: distrib. on infl.	2	266
65	Fruit: sutures	2	266
29	Inflorescence axis: presence	3	264
42	Perianth segments: number	5	259
25	Venation	5	257
51	Anthers: orientation	4	255
01	Plants: nutrition	2	248
07	Stem type	4	245
63	Fruit nature	2	245
35	Flowers: pedicel	2	242
49	Anthers: appendages	2	232
18	Leaves: ligules, stipules, etc.	3	221
30	Main axis of infl.: continuity	2	221
02	Plants: herbaceous or woody	2	220
26	Flowers: scape	2	198
33	Flowers: insertion on infl.	2	190
66	Perianth on fruit: persistence	2	189
28	Inflorescence bract: spathe	2	180
17	Leaf sheath: nature	2	176
73	Seed surface	4	167
76	Distribution: temperate	5	166
74	Seed colour	5	162
39	Perianth: petaloid	2	160

Character number	Description	Number of states	Number of pairs distinguishable
52	Anther locules	3	149
71	Seed appendages	5	148
62	Fruit simple	2	128
77	Distribution: tropical	11	125
45	Staminodes: presence	2	123
67	Fruit: wings	2	110
05	Roots: type	2	108
27	Flowers: aggregation	2	108
12	Special structures	4	103
48	Anther filament: connation	2	99
08	Aerial stem: nodose	2	82
55	Ovary: stipe	2	74
53	Pistillodes: presence	2	54
43	Corona: presence	2	53
22	Leaves: form	2	49
10	Exudate	4	45
23	Leaves: fleshy	2	43
31	Inflorescence: branching	3	42
20	Leaves: cut	3	38
68	Fruit: stones	2	38

NOTE:The remaining five characters (6 Root velamen; 21 Leaves compound; 58 Style or stigma position; 61 Floral nectaries; 72 Seed hairiness) have one or more uncommon states in each which are diagnostic when present in the specimen (see Table 3). But, as a whole character, none of them has any diagnostic power since each has one state that is common to all the 69 families in the polyclave.

TABLE 4

Uncommon character states

Number of the character state	Description	Number of families occurring in
0102	Plants saprophytic	7
0302	Plants climbing or straggling	18
0303	Plants supported by water	15
0402	Plants epiphytic or semiepiphytic	10
0404	Plants of saline habitat	19
0502	Roots tuberous	14
0602	Root velamen present	10
0704	Stem absent	7
0801	Aerial stem nodose	15
1003	Exudate white, yellow or red	11
1004	Exudate resinous	7
1103	Hairs glandular or vesicular	11
1104	Hairs branched	21
1202	Tendrils present	5
1203	Spines or prickles present	16
1204	Cladodes or phyllodes present	4
1301	Leaves absent	4
1302	Leaves reduced to sheaths or scaly	14
1402	Leaves terminally crowded	20
1504	Leaves opposite or subopposite	11
1505	Leaves whorled	11
1702	Leaf sheath closed	13

continued

Table 4 – *continued*

Number of the character state	Description	Number of families occurring in
1802	Leaves stipulate	17
2003	Leaves divided or lobed	10
2102	Leaves pinnately compound	5
2103	Leaves palmately compound	5
2201	Leaves ensiform	15
2301	Leaves fleshy or terete	20
2403	Ptyxis explicative	8
2404	Ptyxis plicate	20
2405	Ptyxis conduplicate-plicate	10
2406	Ptyxis involute	16
2505	Venation reticulate	14
2901	Inflorescence axis absent	13
3103	Infl. axis branched more than once	23
3401	Floral bracts absent	21
3403	Floral bracts more than one	11
3603	Plants dioecious	23
3604	Plants polygamous	14
3801	Perianth caducous, reduced or absent	20
4001	Perianth inconspicuous	21
4201	Perianth segments one	7
4202	Perianth segments two	7
4203	Perianth segments three	12
4205	Perianth segments more than six	9
4302	Corona present	10
4401	Fertile stamens one	23
4402	Fertile stamens two	16
4404	Fertile stamens four	18
4405	Fertile stamens five	13
4407	Fertile stamens seven to ten	16
4408	Fertile stamens more than ten	12
4701	Anthers sessile or subsessile	22
5002	Anthers transidehiscent	5
5003	Anthers poricidal	12
5104	Anthers versatile	18
5201	Anthers unilocular	19
5203	Anthers plurilocular	6
5302	Pistillodes present	15
5402	Ovary semisuperior	13
5502	Ovary stipitate	15
5602	Ovaries per flower more than one	14
5703	Styles free	20
5801	Styles eccentric	10
6003	Placentation apical	18
6005	Placentation marginal	10
6202	Fruit syncarpic	5
6501	Fruit one sutured or circumscissile	13
6701	Fruit winged	14
6801	Fruit with stones	15
7001	Seed linear to fusiform	14
7006	Seed arcuoid, cochleate, reniform or conchiform	23
7104	Seed winged	15
7201	Seed comose, glochidiate or pilose	13
7303	Seed muricate, spinulose, tuberculate or verrucose	21
7501	Distribution only temperate	1
7502	Distribution only tropical	9

CONDITIONAL CHARACTERS

The occurrence of certain characters depends on certain states of some other characters. The former are the controlled (dependent) characters and the latter are the controlling character states. In Table 2 and on the cards, the controlling character states are indicated by 'C' and the dependent characters by 'D', 'DD' or 'DDD' depending upon the number of (one, two or three) character states controlling it. For example, characters 14 to 25 (concerning leaves) are dependent upon the presence of normal leaves (cs. 1303) and become inapplicable if the leaves are absent (cs. 1301) or are reduced to sheaths or scales (cs. 1302). A state of a dependent character may, in its turn, be controlling another character. For example, cs. 1601 (leaf base not sheathing), which is dependent upon cs. 1301 and 1302, controls ch. 17 (leaf sheath open or closed). When irrelevant, the respective family holes in the cards of dependent character states are not punched. This does not matter since there is no reason to use such cards when handling real specimens. However, unnecessary shuffling of cards could be avoided and time saved if the controlling states and dependent characters are kept in mind. A list of these is given in Table 5.

INFLORESCENCE AND FRUIT TYPES

The conventional way of dealing with infloresence and fruit types is largely inadequate and confusing in a large number of taxa, particularly to a non-professional botanist. To ease the situation, the inflorescence and fruit types were broken down into the component characters and states instead of dealing with them as 'syndromes' (see ch. 27—35 and 62—69; Table 2). If one wishes, it is still possible to reconstruct the conventional types by assembling the relevant cards of the component features of any type.

EXCEPTIONS AND VARIATION

In order to account for as much variation and as many exceptional states as possible, data were largely scored at the specific level. Information was gathered from descriptions in numerous floras, monographs and other relevant publications the world over. Uncertain aspects were checked against herbarium specimens. Nevertheless, we are conscious that we have not seen the whole range of variation and exceptional states. Frequent testing of the polyclave on known specimens and the consequent revision, will help to improve the reliability of the polyclave in this respect.

In doubtful cases, the relevant alternative of a character state was also scored. This may 'dilute' the end result occasionally and key out a specimen to its family and one or more allied families. But treating doubtful cases as negative for certain character states may totally block the process of identification.

Incorporation of the large number of exceptional states and the wide range of variation that we encountered has, to some extent, amplified the problem of theoretical combinations associated with polyclaves. For example, *Isophysis* (endemic to Tasmania) is the only genus of the Iridaceae with a superior ovary but its other features (e.g., distichous ensiform leaves and three-stamened flowers) are characteristic of the Iridaceae. In the Liliaceae, occasional examples of distichous and/or ensiform leaves or three-stamened flowers do occur, but they are associated with a superior ovary. So far as we know, all these three features never occur simultaneously in the Liliaceae; if they do, that taxon, like *Isophysis*, does not fit into the Liliaceae. In practice there is very little chance of overlap between Iridaceae and Liliaceae, but the data incorporated in the polyclave project such an overlapping theoretical combination for Liliaceae. Large families with a wide range of variation occasionally overlap with allied families, a problem that may arise more frequently in the so-called

TABLE 5

Conditional characters

	Controlling states	Controlled characters
7.1	Stem—rhizome	8 Aerial stem nature
		9 Stem branching
7.2	Stem—not rhizome	8 Aerial stem nature
		9 Stem branching
7.4	Stem—absent	8 Aerial stem nature
		9 Stem branching
13.1	Leaves—absent	14 Leaves distribution
		15 Leaves arrangement
		16 Leaf base—sheath
		17 Leaf sheath nature
		18 Leaves—ligules, etc.
		19 Leaves—stalk
		20 Leaves—cut
		21 Leaves—compound
		22 Leaves—form
		23 Leaves—fleshy
		24 Leaves—ptyxis
		25 Leaves—venation
13.2	Leaves—reduced to sheaths or scaly	17 Leaf sheath nature
		18 Leaves—ligules, etc.
		19 Leaves—stalk
		20 Leaves—cut
		21 Leaves—compound
		22 Leaves—form
		23 Leaves—fleshy
		24 Leaves—ptyxis
		25 Leaves—venation
16.1	Leaf base—not sheathing	17 Leaf sheath nature
27.1	Flowers solitary	28 Inflorescence bract spathaceous
		29 Inflorescence axis
		30 Main axis of inflorescence continuous
		31 Inflorescence axis branching
		32 Flowers distribution
		33 Flowers—insertion on inflorescence
29.1	Inflorescence axis absent	30 Main axis of inflorescence continuous
		31 Inflorescence axis branching
38.1	Perianth—caducous, reduced or absent	39 Perianth petaloid
		40 Perianth conspicuous
		41 Perianth—number of whorls
		42 Perianth segments—number
		43 Corona
		46 Stamens—adnation to perianth
		66 Perianth—persistent in fruit
47.1	Anthers—sessile or subsessile	48 Filaments—connation
50.3	Anthers—poricidal	51 Anther orientation
54.3	Ovary inferior	55 Ovary stipe
63.2	Fruit—dry	68 Fruit—stones
64.1	Fruit—indehiscent	65 Fruit—sutures
75.1	Distribution—temperate	77 Distribution—tropical
75.2	Distribution—tropical	76 Distribution—temperate

Lilialean complex. For example, some taxa of the Alliaceae, Agapanthaceae and Gilliesiaceae (recognised by some taxonomists but not here) may key out to both Liliaceae and Amaryllidaceae. For reasons already explained (see p. 19), recognising such families for our purpose is no solution. They would only increase the number of overlapping families. The following is a computer-generated list of families that may occasionally overlap with other families in the list, due to theoretical combinations, particularly when dealing with incomplete material. The number of such overlapping families is given in parenthesis in each case:

Liliaceae (13); Amaryllidaceae (10); Iridaceae and Poaceae (7 each); Bromeliaceae and Hypoxidaceae (5 each); Araceae, Agavaceae, Haemodoraceae and Restionaceae (4 each); Juncaceae (3); Hydrocharitaceae, Tecophilaeaceae, Alstroemeriaceae, Philesiaceae, Sparganiaceae, Arecaceae, Taccaceae, and Cyperaceae (2 each); Posidoniaceae, Zannichelliaceae, Flagellariaceae, Xyridaceae, Eriocaulaceae, Trilliaceae, Typhaceae, Velloziaceae, Burmanniaceae and Centrolepidaceae (1 each).

This list does not imply that the Liliaceae overlap with 13 other families every time nor the Amaryllidaceae with ten families and Bromeliaceae with five. These are only the possibilities.

INADEQUATE AND MISSING INFORMATION

Data on indumentum (ch. 11), ptyxis (ch. 24) and seed characters (ch. 70—74) are incomplete, as the relevant information was either inadequately dealt with or more often altogether missing from the literature. The cards concerned should be used cautiously. Character states of this kind are treated as positive even for those taxa where no information was available. If treated as negative, there is a chance of the closed representative holes blocking the process of identification even though the character state does occur in a family but was not recorded. Information on these characters should be continuously updated by studying properly authenticated material.

GEOGRAPHICAL DISTRIBUTION

Sixteen areas were delimited to score distributional data in this polyclave (see Table 2 & Map). These were largely based on the Floristic Regions of the World defined by Takhtajan (1969, 1978). The base map used is the recent Peters' Projection map. For reasons of program compatibility, the phytogeographic areas are grouped into predominantly temperate and predominantly tropical (see ch. 75, 76 & 77), instead of treating them as a single character unit. Details of the areas are given in the Notes on Characters (Table 6). An alphabetical list of world countries, territories, archipelagos and major islands is given in Appendix IV. We hope that, if the notes are read in conjunction with the map and Appendix IV, referring any part of the world to one of the phytogeographical areas recognised here would not be difficult. By using the card of a specific area, the polyclave can be converted into a more local key. Only those taxa that are indigenous or those that were recorded as naturalised in an area have been included. There are many differences in the delimitation of families in various floristic works. In view of this, the distributional data were recorded at the genus level.

Care should be taken to verify whether the specimen in question comes from cultivation. If the locality of collection of the specimen is near the border of two neighbouring areas, both the relevant cards should be used alternatively. Since neither the delimitation of the areas in actual terms nor the records of occurrence of taxa in a particular area can be very precise, some omissions are likely.

TABLE 6

Notes on characters

Characters/states for which notes are given here are indicated by an asterisk (*) in the list of characters (Table 2) and on the cards as well. Technical terms used here are explained in the glossary (Appendix I). Figure numbers refer to the illustrations in Appendix I.

Character/ state number	Notes
2.2	Aborescent: also includes thick soft-woody stems as in some aroids and zingibers
3.3	Supported by water: free floating plants or rooted weak-stemmed plants that require the buoyancy offered by water
4.4	Saline habitat: aquatic marine habitats, coastal sands, coastal or inland salt marshes
9	Stem branching: branching of only aerial stems; branched scapes not included
10	Exudate colour: includes mucilage also; should be examined only in fresh specimens by cutting the stem, petiole or the peduncle; should show a visible welling up of fluid on the cut surface; mere wetness or stickiness not included
11	Hairs: on vegetative parts only; hairs on floral parts, fruits and seeds not included
11.4	Branched hairs: T-shaped, much branched hairs or peltate scales included (Figs 5 to 9)
12.1	Special structures: tendrils of any origin, prickles, spines, thorns, cladodes, phylloclades, cladophylls or phyllodes
14.1	Basally crowded: radical leaves or spirally arranged cauline leaves crowded at the base of the stem; there may be other cauline leaves rather uniformly distributed
14.2	Terminally crowded: leaves may be present on the lower part of the stem but most crowded at the ends of branches as in palms and some zingibers
15.1,2	Leaves spiral or alternate: the difference between alternate and spiral is in the degree of closeness of the spiral formed by the leaves (Figs 10 to 13); most spiral cases are also covered in 14.1 and 14.2
18.1	Squamulae intravaginales are small scales, glands or finger-like appendages occurring in the axils of vegetative leaves (Figs. 19, 20); ligules are outgrowths of tissue from the adaxial surface of the leaves close to the junction of the leaf sheath and lamina (Figs 21); pulvini are swellings at the base or the top of the petiole
18.3	Eligulate and estipulate: includes taxa without the kinds of appendages mentioned in 18.1
22	Ensiform leaves: leaves with an equitant base and an isobilateral lamina; anatomically they show an inverted orientation of the vascular bundles (Figs 24 to 27)
24	Ptyxis: the manner in which individual parts are folded in bud; vernation is the vegetative equivalent of aestivation of perianth and deals with the relationship of several members of a bud to each other; most of the information on ptyxis was based on Cullen (1978) and Tomlinson (1969, 1982) (Figs 28 to 35)
29.3	Inflorescence axis thick: includes thick axes of a typical spadix, maize cob and the peduncles of some amaryllids, liliads, zingibers and palms—fleshy, fibrous, semiwoody or woody
38.1	Perianth reduced: includes all cases where the perianth is interpreted to be represented by scales, hairs or bristles; do not use this card if petals are normal (though caducous) and could be examined in buds
49	Anther appendages: includes penicillate or apiculate anthers, extended sterile anther lobes, extended connectives and clearly formed appendages of whatever origin (Figs 51 to 59); hairs on filaments not included
51.4	Anthers versatile: as in grasses; to be judged from mature anthers as the filament may be initially adnate and later become separated from the basal part of the anthers (Figs 45, 50)
55	Ovary stipitate: stipe is different from the pedicel (Figs 71, 72); also includes the stipitate condition of the fruit (Fig. 73)
61	Floral nectaries: more or less localised areas secreting nectar; nectaries are sometimes morphologically similary to the surrounding parts
68	Fruit stones: includes fruits with hard seeds in pulp
70.6	Seed shape: includes shapes of semilunar or spiral patterns also
71.5	Seed appendages: includes beaks, tails, arils, caruncles, coronae, operculae and wings

73.1 Seed surface: folded or loose wrinkled testa included

75 Distribution: these cards give only a general pattern of distribution; details are dealt with in 76 and 77 (also see Map)

76.1 Circumboreal: Arctic coast and islands, Europe, Illyria (Balkan), Euxine, Caucasus, Siberia, Altai-Saya, Transbaykalia, Okhotsk-Kamchatka and Canada (Subarctic America)

76.2 Atlantic North American: Appalachian Range, Atlantic-Gulf Coastal Plain, North American Prairies, Sitka-Oregona and Rocky Mountains

76.3 Tethyan: Azores, Canaries, Madeira, Cape Verdes, Southern Morocco, Mediterranean Islands, Iberia, Balearia, Liguro-Tyrrhenia, Adriatic, Krym-Novorossiysk, Sahara, Egypt, Arabia, Mesopotamia, Central Anatolia, Armeno-Iran, Hyrcania, Turania (Aralo-Caspia), Turkestan, North Baluchistan, Western Himalayas, Central Tien Shan, Dzungaro-Tien Shan, Mongolia and Tibet

76.4 Eastern Asiatic: Manchuria, Sakhalin-Hokkaido, Japan, Korea, Volcano-Bonin, Ryukyu (Tokaro-Okinawa), Taiwan, North and Central China, Sikang-Yunnan, North Burma, Eastern Himalayas and Khasi-Manipur

76.5 Antarctic: Fernandez, North and Middle Chile, Pampea, Patagonia, Magellania, Trista-Goughia, Kerguelenia, Lord Howea, Norfolk, Kermedicia, New Zealand, Chatham and New Zealand Subantarctic Islands

77.1 Madrean: Great Basin, California, Sonora and Mexican Highlands

77.2 Neotropical: Central America, West Indies, Galapogos, Guayana, Amazon basin, Llanos, Caatinga, Uplands of Central Brazil, Chaco, Atlantic coast, Parana, North and Central Andes

77.3 African: Guinea, Congo basin, Saheli, Sudan, Nubo-Arabia, Omano-Rajasthan, Somalo-Ethiopia, South Arabia, Socotra, Zambesia, Karroo, Namaqualand, Namib, Ascension and St. Helena Islands

77.4 Cape: Cape Region (South Africa)

77.5 Madagascan: Madagascar, Sambirano, Comoro, Mascarenes and Seychelles

77.6 Indian: Sri Lanka, Malabar, Deccan and Gangetic Plain

77.7 Indo-Chinese: Eastern Assam, Southern China, Southern Burma, Andaman and Nicobar Islands, Thailand, Annam and Cambodia

77.8 Malesian: Malacca, Kalimantan, Philippines, Sumatra, Southern Malesia, Sulawesia, Molucca, Irian Jawa, Papua New Guinea and Bismarck Islands

77.9 Fiji-Polynesian: New Hebrides, Fiji, Micronesia, Polynesia, Johnston and Hawaii Islands

77.10 Neocaledonian: Neocaledonia, Isles of Pines and Loyalty

77.11 Australian: Australia

HOW TO USE THE POLYCLAVE

1. Before using this polyclave to determine the family to which a specimen belongs, make it certain that it is a monocotyledon. In order to do this, look for the following *usual* characters of monocots: Roots fibrous; leaves narrow, rarely opposite or whorled, no distinct petiole, leaf base broad and encircling the stem; prophyllum (first bract of the inflorescence or solitary flower) single; floral parts in sets of or multiples of three; stem vascular bundles numerous, scattered (not in a ring), closed (no vascular cambium) and with a sclerenchymatous bundle sheath; embryo small, with one cotyledon and a scutellum (organ to absorb nutrition from the endosperm). It should be remembered that all these features are variable and that many exceptions do occur in the monocots. Taken singly, none of them can completely and infallibly separate all the monocots from the dicots; look for a combination of several of these features.

2. Familiarise yourself with the character states represented by the cards with the help of the notes on characters (Table 6) and the illustrated glossary (Appendix I). To use this polyclave there is no need to look for characters other than those represented by the cards.

3. Examine the specimen for the character states present and preferably list them.

4. Choose from the pack of cards, only those cards representing the character states actually found in the specimen. Some cards represent negative states. Cards may be chosen in any order. If the specimen shows two states of the same character, both the cards may be used but alternatively, i.e., not both together. Do not use any card if you are in doubt about the meaning of the term or the occurrence of the state in the specimen.

5. If the specimen is incomplete (for example, with only flowers or fruit; flowering material of deciduous plants) you should ignore the cards concerned with those parts absent from the specimen.

6. Superimpose the chosen cards, their alignment guided by the cut corner at the top. As you superimpose the cards one by one, you should notice that, progressively, more and more holes become obscured indicating the elimination of families with character combinations irrelevant to the specimen being identified.

7. Continue to process of selection and overlaying of the cards till only one hole is left or the specimen does not allow the use of any more cards.

8. Hold the entire stack of the chosen cards and look up to light or against a dark background for the hole or holes running right through the stack. If the key is used indoors, a rear-illuminated translucent panel such as the one used to study x-ray photographs or photographic slides is well suited for this purpose.

9. If only one hole is left, the name of the family represented by that hole is found from the list of families (see Reading Families on Cards, p. 11 and list of families, Table 1).

10. According to the data stored in the cards, the character combination chosen by you, based on the character states of the specimen, is present in the family represented by the remaining hole. Logically your specimen belongs to this taxon.

11. This identification should be verified by checking against descriptions of the family concerned in floras covering the locality of the specimen.

12. If more than one hole remains and no more cards can be used, the descriptions of all the families indicated should be checked to determine the family.

13. If no holes are left, then the specimen and the chosen cards should be re-examined. When held against strong light, it is usually possible to find, by the translucence of the holes, which cards are actually blocking the process of identification. These cards and those about which you are not absolutely certain should be removed from the stack and reassessed; if possible choose new cards.

14. Generic and specific identification should be carried out with the help of the relevant floras, monographs and/or by comparing with herbarium specimens, if this is feasible.

SOME GENERAL SUGGESTIONS

1. Handle the cards with care protecting them from dirt and moisture. Bent cards, warped edges and curled up corners will affect proper alignment of the cards, which is very important.

2. Keep the cards in their proper sequence after use; this will make their subsequent use less cumbersome.

3. Although you can use the cards in any sequence, it is better to proceed in an orderly manner in the sequence of characters and character states as given in the list, except when some parts are missing from the specimen. However, it saves time if characters with a strong diagnostic power (Table 3) and the uncommon states (Table 4) are used first, so long as this is feasible.

4. To become familiar with the polyclave, start with specimens of a few well known representatives of some families. This will also give you an idea of the probable mistakes you are likely to commit while using the key.

5. It is better to make a list of character states present in the specimen before the cards are selected from the pack. This will make a reassessment of chosen cards easier.

6. Most character states can usually be observed with the unaided eye. However, the use of a 10× lens will make observations easier and your judgement of character states more certain.

7. As you select the cards and stack them, keep a watch for any card that is closing all the holes. If this happens, keep that card aside for a reassessment. The key may be incorrect in omitting that state for the family, but a reassessment of such character states in the specimen is a fair requirement.

8. Bear the following in mind: Leaves may be absent at the time of flowering (ch. 13); determine ptyxis only from young (vegetative) buds (ch. 24); scapes may have large leafy bracts and look like vegetative axes bearing flowers (ch. 26); distinguish between pedicel and inflorescence axis (ch. 27 to 33); determine anther orientation only from mature but unopened flowers (ch. 51); examine both transverse and longitudinal sections of the ovary to determine the placentation and the total number of ovules per locule (ch. 59, 60); intruding parietal placentae may be appressed against each other and the placentation may then appear axile (ch. 60); study only mature fruits for ch. 62 to 69; count the seeds from the entire fruit (ch. 69); and distributional data (ch. 75 to 77) do not represent taxonomic characters of the families—hence they should be used at the end.

MODIFYING THE POLYCLAVE

This polyclave can be modified, introducing corrections or additions of new characters/states, without affecting its basic structure.

If you notice an erroneous inclusion of a character state for any family, simply close the relevant hole with a piece of adhesive paper. If an obvious character state in a known family has been omitted by us, carefully make a hole with a sharp instrument in the family's assigned position on the relevant card.

If you want to add new characters/states, use a blank standard computer card and make holes in the appropriate positions. When you add new characters/states, it is essential that you possess information on the presence or absence of the characters/states in all the families. Uncritical partial information adversely affects the working of the key.

When you improve your own set please let us have the benefit of your knowledge. We will publish corrections and additions as and when necessary.

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APPENDIX I

Glossary

This glossary was mainly based on Jackson (1928) and Stearn (1983) besides a number of other works. To make it reasonably comprehensive, all the terms used in the text and in describing the character states, as well as those that arose in the glossary itself, are included. Our experience with students at various levels and amateur botanists prompted us to include many common terms to make the use of the key easier for them.

ABAXIAL: the side away from the axis
ACTINOMORPHIC: flowers with a regular star-like pattern; can be divided into two equal halves in more than one plane
ADAXIAL: the side facing the axis
ADNATE (-TION): fusion of different kinds of parts (non-homologous); e.g. petals with stamens (Figs 45, 46)
ADPLICATE: (ptyxis) (= flat, straight or stiff) neither folded nor curved
AERIAL: above the surface of ground or water
AESTIVATION: arrangement of parts with reference to each other in the flower bud; equivalent of vernation of leaves
ALGORITHM: a series of logical instructions to the computer to solve a specific problem
ALTERNATE: arranged singly without crowding, on the axis at less than 180° from each other forming a spiral around the axis (Figs 10, 12)
ANDROECIUM: the male part of a flower composed of stamens
ANTHER (LOBES): the usually terminal enlarged part of the stamen composed of one, two or more lobes each containing pollen
APICAL: near the end of a part or organ
APICAL PLACENTATION: ovules arising from the roof of the ovary locule (Figs 93, 94); then ovules pendulous
APICULATE: small projection, blunt or pointed, at the apex of an organ (e.g. anthers Figs 53, 54)
APPENDAGES: parts attached to an organ but not forming the body of the organ
AQUATIC: living on or in water
ARBORESCENT: woody perennial plant attaining the size and/or characters of a tree; shrubs included here
ARCUOID (ARCUATE): curved like a bow
ARILLATE: seeds with a fleshy (or membranous) covering over the seed coat
ASYMMETRIC: flowers which cannot be divided into two equal halves in any plane; different from zygomorphic; asymmetry may be due to reduction/modification leading to dissimilarity of perianth and/or androecium
AUTOTROPHIC: green, non-parasitic and non-saprophytic
AXIL: the angle formed between one organ and another from which the former arises (e.g. leaf axil—between a leaf and the stem)
AXILE PLACENTATION: ovules arising on a central column in an ovary with more than one locule
AXIS: the (usually) elongated part of the plant (e.g. stem, inflorescence) around which other parts (e.g. leaves, flowers) arise

BASAL: near the base of an organ or part
BASAL PLACENTATION: ovules arising from the floor of the ovary locule (Figs 94 to 96); then ovules erect
BEAK: a long pointed projection with a broad base like the bill of a bird
BODY PUNCHED CARD: punched card where the punch positions are arranged all over the card in rows and columns (e.g. cards in the present polyclave)
BILOCULAR: (anther/ovary) with two cells/chambers; bilocular anthers are tetrasporangiate
BRACT: a reduced or modified leaf subtending the inflorescence or flower, sometimes brightly coloured

BRACTEOLE: a small bract-like structure occurring above the bract (on the pedicel or at the base of the flower)
BUD: a group of developing leaves or flowers before full expansion

CADUCOUS: dropping off very early (e.g. perianth members, bracts)
CARPEL: a highly modified leaf; a component of a pistil
CARUNCLE (-ATE): seed with a wart or protuberance near the hilum which is not a part of the seed coat
CAULINE: on the stem
CHARACTER: an abstract basis of comparison of taxa; any attribute (morphological, anatomical, chemical, etc.) useful in classification
CHARACTER STATE: one of several forms in which a character can occur
CIRCUMSCISSILE: dehiscing as if cut circularly around
CLADODE: a flattened branch of a single internode resembling and functioning as a leaf
CLADOPHYLL: a thin cladode resembling a leaf more than a cladode
CLIMBING: reaching up (ascending) by using other objects as supports
CLUSTER ANALYSIS (METHODS): means of assessing relationships among taxa through the application of mathematical procedures usually requiring a computer
COB: the female inflorescence of maize with a thick axis
COCHLEATE: (seed) coiled like a snail's shell; not in the sense of aestivation
COMOSE: (seed) with tufted hairs
COMPOUND: made of many similar separate parts (e.g. leaf, ovary, fruit)
CONCHIFORM: (seed) shaped like the half-shell of a bivalve mollusc
CONDITIONAL STATE: a character state on whose presence depends the occurrence of another character
CONDUPLICATE: (ptyxis) two halves folded lengthwise along the midrib so that the adaxial surfaces of the two halves face each other (Fig. 30)
CONDUPLICATE-PLICATE: (ptyxis) like conduplicate but each half is pleated separately lengthwise again (Fig. 33)
CONFOR: a program to convert descriptions of taxa in DELTA format into natural language or into the formats required by other programs
CONNATE (-ATION): fusion of the same kind of (homologous) parts; e.g. petals (Fig. 46) or stamens (Fig. 48) among themselves
CONNECTIVE: the central column of tissue of the anther holding the anther lobes together (Figs 53 to 59)
CONTROLLED CHARACTER: same as dependent character
CONTROLLING STATE: that controls the occurrence of a different character
CONVOLUTE: (ptyxis) (=supervolute) (Fig. 35)
CORONA: petaloid, horn or thread-like, appendages arising between the petals and stamens often fusing to form a crown-like structure
CORONATE: a flower or seed with a crown-like appendage
COSTATE: with long ribbon-like processes
CURVED: (ptyxis) bent longitudinally, slightly and smoothly but not sharply (Fig. 29)
CYLINDRICAL: elongated and circular in cross section

DATA: specific information on any aspect (singular: datum)
DATA BASE (BANK): information stored in the computer in a numerically or symbolically coded machine readable language for a particular use
DATA MATRIX: presentation of data in the form of a table of rows and columns
DATA RETRIEVAL: mechanical or electronic access to information stored in an orderly manner
DATA STORAGE: storage of information in an orderly manner by mechanical or electronic means
DECIDUOUS: plants that shed leaves seasonally
DEHISCENCE: opening of anthers/fruits at maturity to release pollen/seeds
DELTA: DEscription Language for TAxonomy
DENTATE: toothed, the teeth pointing outwards
DEPENDENT CHARACTER: character that can occur only when another character state is present in the specimen
DESCRIPTION: an orderly listing of characters of an organism in technical terms
DETERMINE (-ATION): identification of a specimen

DIAGNOSIS: a short description containing only those character states that help in differentiating a taxon from related taxa
DIAGNOSTIC: (characters and states) that help in distinguishing related taxa
DIAGNOSTIC POWER: (character) the capacity of a character to distinguish between the members of a pair of taxa
DICHOTOMOUS KEY: an artificial device to identification by means of pairs of contrasting character states
DIOECIOUS: male and female parts (flowers) on different plants
DISTICHOUS: arranged in two vertical rows (ranks) on the axis at about 180° from each other (Figs 10, 13)
DISTRIBUTION: the occurrence of taxa in various geographical regions (geographical distribution) or of characters and states in various taxa (character distribution)
DIVIDED: lobes or segments extending more than half way from the margin
DORSIVENTRAL: the upper and lower sides dissimilar in form/function
DRY: (fruit) not fleshy or juicy; devoid of water

ECCENTRIC: (=excentric) towards one side; away from the centre (e.g. style Figs 84, 85)
EDGE-PUNCHED CARD: a punched card where the punch positions are arranged along the margins of the card; cannot be used with computers
ELIGULATE: without ligules
ELLIPSOID: longer than broad and with rounded ends
ENSIFORM: (isobilateral leaf) shaped like a two-edged sword, gradually tapering to a point and with an equitant base (Figs 24 to 27)
ENTIRE: margin even; without incisions or teeth
EPIPHYTE: plant growing on other plants; not rooted in the ground and non-parasitic
EQUITANT: (leaf base) overlapping; astride (like riding a horse) (Figs 24 to 26)
ERECT: upright; more or less straight; perpendicular to the ground or another organ
EXSTIPULATE: (=estipulate) without stipules
EXPLICATIVE: (ptyxis) with two sharp abaxial bends, one in each half of the leaf, midway between the midrib and the margin (Fig. 31)
EXTRORSE: lines of anther dehiscence facing outwards (perianth) (Fig. 63)
EXUDATE: sweat-like flow from cut ends of stems and petioles (or like parts)

FASCICLE: a close group (cluster) of leaves or pedicellate flowers apparently arising from the same point on the axis (Fig. 38)
FERTILE: (anthers/ovaries) with functional pollen/ovules
FIBRE: fine, long and thread-like
FIBROUS: looking like fibres
FILAMENT: the stalk of an anther (Figs 45, 50)
FLAT: (ptyxis) neither curved nor folded; also straight, stiff or adplicate; (Fig. 28)
FLESHY: (leaves/fruits) soft, thick and succulent
FLORA: the publication that gives a systematic account of the vegetation of an area; also the vegetation of an area
FLORISTIC REGION: a geographical area demarcated on the basis of the types of vegetation occurring in that area
FUNICLE: the thread-like structure connecting the ovules to the placenta
FUSIFORM: longer than broad, thick in the middle and tapering at both the ends; spindle shaped

GLABROUS: without pubescence (nairs)
GLANDULAR: secreting watery or sticky fluid; applied to an organ or superficial or embedded part
GLOBOSE: more or less spherical
GLOCHIDIATE: with barbed bristles
GYNOECIUM: the female part of the flower composed of pistils (Figs 75 to 85)

HEMISPHERICAL: half-rounded, half-flat
HERBACEOUS: non-woody or woody only at the base of the plant
HERBARIUM: plant specimens preserved (usually by a slow process of pressing and drying) for study; also the institution that houses them
HERMAPHRODITE: with both stamens and pistils occurring in the same flower
HETEROCHLAMYDEOUS: two or more whorls of perianth, dissimilar in size, shape or colour

HILUM: the scar on the seed where the funicle or placenta was attached earlier
HOMOCHLAMYDEOUS: two or more whorls of perianth, similar in size, shape and colour
HOMOGENOUS: more or less uniform; taxa with variation within narrow limits implying common ancestry (opposite term: heterogenous)
HYPANTHIUM: the torus (floral axis) enlarged below the calyx (Figs 67 to 70)

IDENTIFICATION: referring an unknown bioligical specimen to a known group in a classification
INDEHISCENT: not opening to release pollen/seeds
INDIGENOUS: native to a given area
INDUMENTUM: the covering, usually of hairs, scales, etc., on vegetative and floral parts, etc.; here only vegetative parts were considered
INFERIOR OVARY: completely fused with hypanthium so that the other floral parts seem to arise from above the vary (Fig. 70)
INFLORESCENCE: arrangement of flowers on the floral axis
INSERTION: point and mode of placement of organs/parts
INTRORSE: line of anther dehiscence facing the centre of the flower (Fig. 62)
INVERTED ORIENTATION: two rows of vascular bundles with xylem in each row facing the xylem in the other when seen in cross section (Figs 24 to 27)
INVISIBLE: (venation) not clearly seen; buried in the leaf tissues
INVOLUTE: (ptyxis) both edges of the leaf separately and adaxially rolled in, lengthwise (Fig. 34)
ISOBILATERAL: (leaves) with both sides looking alike (Fig. 24 to 27)

KEY: an artificial device for biological identification
KEYGEN: a key generating program

LAMELLATE: leaf-like; spread out and thin, green or otherwise
LAMINA: thin, flat blade of a leaf or perianth segment
LAMINAL PLACENTATION: (=superficial, laminar or dispersed) ovules arranged all over the inner surface of the ovary wall without any apparent order (Figs 91, 92)
LATRORSE: anthers dehiscing on the sides; lines of dehiscence of neighbouring anthers facing each other (Fig. 64)
LATEX: juices of plants, usually milky; may change colour on exposure to air
LENTICULAR: lens-like; bulged (convex) on both sides
LIGULE: thin, often scarious, projection from the tip of the leaf sheath at the base of the lamina (Fig. 21); may be reduced variously sometimes to bristles
LINEAR: straight and rather slender; many times longer than broad
LOBED: leaves or petals divided less than half-way from the margin
LOCULE: a cavity; a cell of an anther or ovary
LONGIDEHISCENT: dehiscing lengthwise (Figs 56, 57)
LUSTROUS: shining

MARGINAL PLACENTATION: ovules arising from a single ridge on the inner surface of the wall of a monocarpellary (unilocular) ovary (Figs 97 to 100); ovules may be pendulous, if few
MATCHING METHODS: methods of specimen identification by a simultaneous comparison of all the character states in the specimen with the information in the data base; makes use of similarity coefficients
MONOECIOUS: stamens and pistils borne in separate flowers on the same plant
MONOGRAPH: publication containing a systematic account of a particular order, family or genus
MOTTLED: blotches or patches of a colour (or shade) different from that of the background
MULTI-ACCESS: identification systems with many points of entry (e.g. polyclaves)
MULTILOCULAR: (=plurilocular) (anther/ovary) many celled
MURICATE: rough with short and hard tuberculate outgrowths

NATURALISED: a species established and growing wild in an area that is not its original home
NECTAR: sugar containing liquid secreted by specialised parts of plants
NECTARY: the specialised region secreting nectar; nectaries are usually present in the flowers (floral); can occur on vegetative parts also (extrafloral) but not considered here
NODOSE: with swollen nodes giving a knotty appearance

OBLONG: longer than broad with nearly parallel sides
ON LINE IDENTIFICATION: (interactive methods) specimen identification system operating

through a 'dialogue' between the user and the computer via a terminal where the user can enter additional information during the execution of the program
OPERCULATE: with a lid-like appendage
OPPOSITE: set against each other (if leaves, in pairs at the same node, Fig. 14)
OVARY: the central hollow part of the flower containing the ovules and composed of one to many united carpels
OVOID: egg shaped; broad at the base and tapering at the apex
OVULE: the rudimentary seed; the body in the ovary that develops into a seed on fertilisation

PALMATE (LEAF): with parts attached in one plane at about the same place (like the fingers of the hand)
PALMATE (VENATION): veins seemingly arising from a single point at the base of the lamina
PANDEL: a program that converts KEYGEN format into DELTA format
PARALLEL: (venation) usually unbranched veins running alongside each other at approximately equal distances
PARASITE: an organism deriving nourisment from another living organism (host)
PARIETAL PLACENTATION: ovules arising from more than one ridge on the inner surface of the wall of a multicarpellary but unilocular ovary (Figs 88 to 90)
PEDICEL: stalk of the flower (Figs 36, 44)
PEDUNCLE: the axis of the flowering branch (inflorescence) (Figs 36 to 44)
PERIANTH: floral parts other than the bracts, stamens and the ovaries (usually calyx or corolla)
PERSISTENT: (perianth, style) remaining till the part which bears them is wholly mature
PETALOID: (=petaline) petal-like; thin and spread out; rarely green; one or both (or more) whorls in a flower can be petaloid
PETIOLE: leaf stalk
PHYLLOCLADE: a flattened branch resembling and functioning as a leaf
PHYLLODE: a flattened petiole resembling and functioning as a leaf
PHYLOGENY: the evolutionary history of a taxon
PILOSE: with soft hairs
PINNATE: with parts attached in one plane on both sides of the axis (like a feather)
PISTIL: the female part of the flower formed of one or more united carpels, style and stigma (Figs 75 to 79)
PISTILLODE: a reduced pistil without functional ovules
PITTED: with small depressions
PLACENTA: that part of the ovary bearing the ovules (plural: placentae) (Figs 86 to 100)
PLACENTATION: the mode of arrangement of placentae and so of ovules in the ovary (Figs 86 to 100)
PLICATE: (ptyxis) folded lengthwise into pleats or furrows along the (parallel) veins (Fig. 32)
PLURILOCULAR: (anther/ovary) (=multilocular) with many cells
POLLEN: the powdery substance in the anthers; male cells of plants
POLLINIA: the waxy aggregations of pollen in the Orchidaceae
POLYCLAVE: a card overlay system with a multi-access potential
POLYGAMOUS: with bisexual (hermaphrodite) and unisexual flowers on the same (polygamo-monoecious) or different (polygamodioecious) plants
POLYSTICHOUS: arranged in many vertical rows (Fig. 11)
PORICIDAL: opening by pores (Figs 60, 61)
PRICKLES: irregularly distributed, short, pointed outgrowths of the rind or bark without vascular supply; not derived from any organ
PROGRAM: the complete sequence of coded instructions and routes needed to solve a problem or to execute directions in a computer; the expression of an algorithm
PROPHYLLUM: the first bract of the inflorescence or solitary flower
PTYXIS: the manner of folding (folds, pleats, clefts or deep grooves) of individual young parts (leaves) in bud (Figs 28 to 35)
PULVINUS (-ATE): the swelling of the petiole at the base or apex
PUNCH POSITION: the position of the machine punched rectangular hole in the computer card located along the numbered rows (horizontal) and columns (vertical)
PYRAMIDAL: shaped like a pyramid; with a broad square base and angled sides tapering to a point

RADICAL: leaves arising from the base of the stem but looking as if arising from the root

REDUCED: diminute; much smaller in size
RENIFORM: kidney shaped
RESINOUS: rather sticky, usually inflammable secretion; may change colour and/or solidify on exposure to air; insoluble in water and often smelling (pleasant or otherwise)
RETICULATE: veins, bands or ridges in the form of a network
RHIZOME: an underground, perennial, dorsiventral stem resembling a root; elongated and usually horizontal with shoots on the upper side and roots on the lower; different from a stolon which is annual
RIMMED: with a prominent edge thickened all along
RUGULOSE: more or less wrinkled; outer skin of fruits and seeds in folds

SALINE: soils or water with a high salt content
SAPROPHYTE: plant without chlorophyll and living on dead organic matter
SCABROUS: hard and rough
SCALY: small, thin, dry, pale and membranous; reduced perianth or an epidermal outgrowth
SCAPE: a leafless inflorescence axis (with or without bracts) arising from about the base of the plant
SCARIOUS: thin, dry, pale and translucent
SEED COAT: the outer covering (testa) of the seed
SEMIAQUATIC: plants rooted in water logged ground
SEMILUNAR: half-moon shaped
SEMISUPERIOR: (ovary) perianth arising at about the middle of the ovary (=semi-inferior) (Fig. 69)
SERRATE: with small teeth pointing towards the apex; like a saw
SESSILE: without petiole/filament/style/funicle (anthers Figs 46, 47; stigma Fig. 81)
SHEATH: the flattened base of the petiole/leaf often enveloping the stem/internode (Figs 15 to 18)
SHRUB: a woody, perennial and much branched plant without a distinct main stem
SIMILARITY COEFFICIENT: a numerically expressed measure of the simultaneous comparison of all character states of two taxa reflecting the degree of their similarity
SIMPLE FRUIT: formed of a single ovary of one or more united carpels
SIMPLE LEAF: entire to divided but not compound
SINGLE-ACCESS: identification systems with only one point of entry (e.g. dichotomous keys)
SMOOTH: not rough or scabrous
SOLITARY: single
SPADIX: inflorescence of sessile flowers on a fleshy axis and with a spathe
SPATHE: an enlarged bract enclosing a young inflorescence or single flower; often brightly coloured
SPINES: sharp, hardened parts with vascular supply (dervied from an organ—leaf or its parts)
SPINULOSE: with very small spine like projections
SPIRAL: if leaves—closely arranged as if wound around the axis forming a polystichous spiral (Figs 10, 11); if other parts—a loose ascending coil
SPIROSCULPTATE: coiled or spiral pattern in relief above the general surface
SQUAMULAE INTRAVAGINALES: appendages in the axils of leaves (Figs 19, 20)
STAMEN: the male organ in the flowers composed of a filament and an anther; a component of the androecium (Figs 45 to 59)
STAMINODE: a reduced non-functional stamen without an anther or with an anther without pollen; staminodes should be excluded while counting fertile stamens in the polyclave
STERILE: (anther/ovary) non-functional
-STICHOUS: in vertical rows or ranks on the axis (Figs 10 to 13)
STIGMA: the papillate/glandular/hairy terminal parts of the style adapted to receive pollen; if there is no style the stigma is sessile and directly inserted on the top of the ovary (Figs 74 to 85)
STIPE: the stalk of the ovary/fruit; not pedicel; occurs between the perianth and the base of the ovary (Figs 71 to 73); sometimes used for the stalk of a sepal or petal
STIPITATE: with a stipe
STIPULE: appendage on either side of the leaf/petiole base (Figs 22, 23)
STONES: (in fruit) strictly the hard endocarp; here any hard seed in fleshy pulp
STRAGGLING: plants with long spreading branches (usually woody or semiwoody) supported by other plants; not climbing plants
STYLE: the part between the ovary and the stigma (Figs 74 to 80)
SUBOPPOSITE: not exactly opposite
SUBSESSILE: with a short petiole/filament/style (Fig. 49)
SUCCULENT: thick and fleshy containing a lot of water, mucilage or juice

SUPERFICIAL PLACENTATION: (=laminal, laminar or dispersed) ovules arranged all over the inner surface of the ovary wall (Figs 91, 92)
SUPERIOR OVARY: free from and arising above the point of placement of the perianth (Figs 65 to 68)
SUPERVOLUTE: (ptyxis) (=convolute) adaxially longitudinally rolled over; rolling starts from one margin and extends to the other so that the longitudinal margin of one side lies completely in the centre and of the other completely outside (Fig. 35)
SUTURE: (fruit) seam (junction) of fusion of carpels; position of lines of dehiscence of the fruit
SYNCARP (-IC): (=multiple or aggregate) a compound fruit formed by the fusion of several originally free carpels of different flowers; not the same as syncarpous which refers to two or more united carpels forming a single ovary with free or united styles
SYNDROME: the occurrence of several different character states together to give a distinctive appearance to the organ; e.g. inflorescence and fruit types which are given separate technical descriptive names but they can each be analysed into component character states as done here

TAIL (-ED): a long and slender prolongation without vascular supply
TAXON: a biological group of any rank; e.g. family, genus; (plural: taxa)
TENDRIL: a long, slender, vascularised and usually coiled organ derived from a vegetative axis, leaf or a part of it or an inflorescence
TERETE: cylindrical, elongated and circular in cross section
TERMINAL (COMPUTER): an input/output device used to enter data into (or retrieve data from) a computer; e.g. hard copy terminal—printer; soft copy terminal—visual display (cathode ray tube) unit
TERMINAL: (style/stigma) arising at the apex (of the ovary) (Figs 74 to 83)
TEMPERATE: regions of the world outside the tropical belt in the northern and southern hemispheres; generally the colder parts of the world
TERRESTRIAL: growing on normally dry ground
TESTA: seed coat, the outer covering of seeds
THORN: a sharp, elongated and pointed object with vascular supply dervied from an axis
TORUS: the flattened terminal part of the floral axis (receptacle) bearing the floral parts (Figs 65, 66)
TRANSIDEHISCENT: (anther) dehiscing transversely (horizontally) (Fig. 59)
TRANSLUCENT: allowing only some light to pass through; neither transparent nor opaque
TREE: a perennial woody plant with a distinct main trunk
TROPICAL: that part of the world in the 'tropical belt' around the earth between the two parallels of latitutde at 23°27′ on either side of the equator; generally the warmer parts of the world
TUBE (-ULAR): fused, usually elongate part of the connate perianth of filaments
TUBER (-OUS): a thickened, short and usually underground part of the plant derived from the stem, hypocotyl or root
TUBERCULATE: with thick, short and blunt projections
TURBINATE: (seed) shaped like a top; broad at the top, narrowing down to a point and circular in cross section

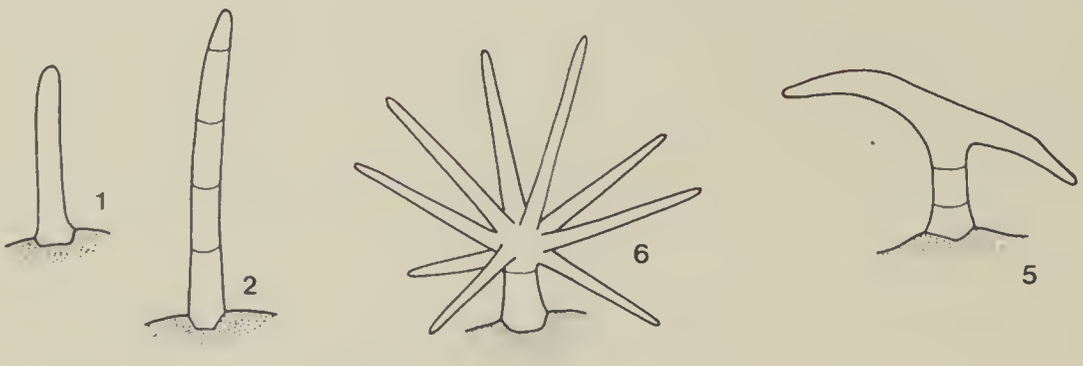
UNILOCULAR: (anther/ovary) with one one cell/chamber; unilocular anthers are bisporangiate

VARIATION: the occurrence of many states of a particular character in the same taxon
VASCULAR BUNDLE: a prominent strand of specialised tissues concerned with transport of water and other substances within plant organs
VEIN: vascular bundles as seen on the surface of leaves, petals, etc.
VELAMEN: a translucent papery layer on the roots, often loose and peeling off
VENATION: the pattern of occurrence of veins in the leaf, petal, etc.
VERNATION: the arrangement of leaves with reference to each other in the bud; vegetative equivalent of aestivation of floral parts
VESICULAR: bladder like; hairs with a single very large terminal cell

WING (-ED): (fruit/seed) a membranous expansion extending from an organ
WHORL (-ED): (leaves/perianth) many parts arising at about the same level and arranged in a circular manner around the axis

ZYGOMORPHIC: divisible into two equal halves in only one plane; bilaterally symmetrical; different from asymmetric; zygomorphy may be due to reduction or modification leading to dissimilarity in the perianth and/or androecium

Ch. 11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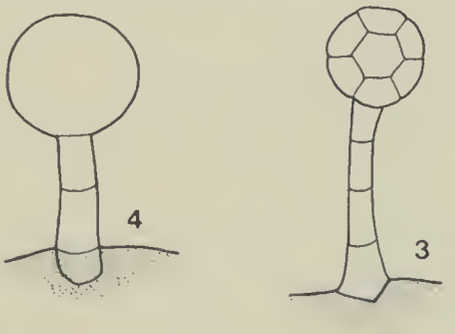
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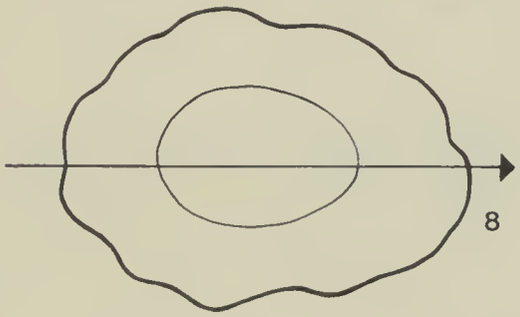
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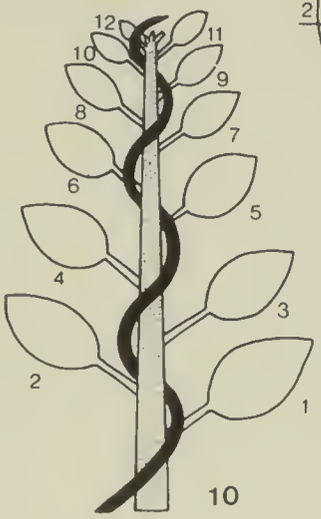
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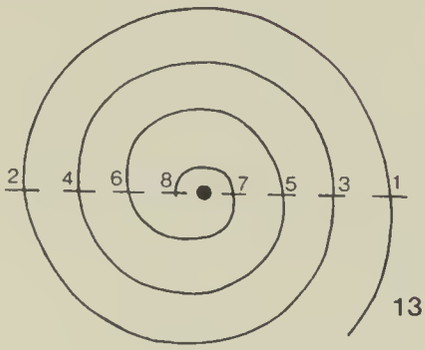
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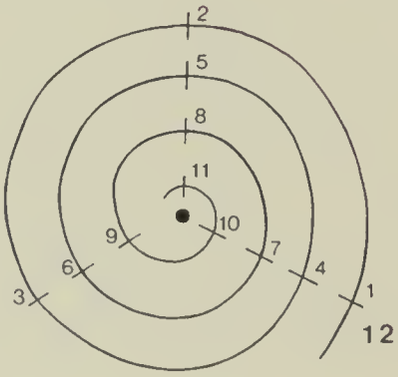
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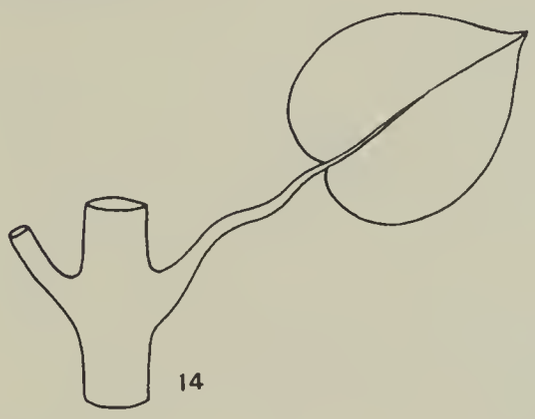

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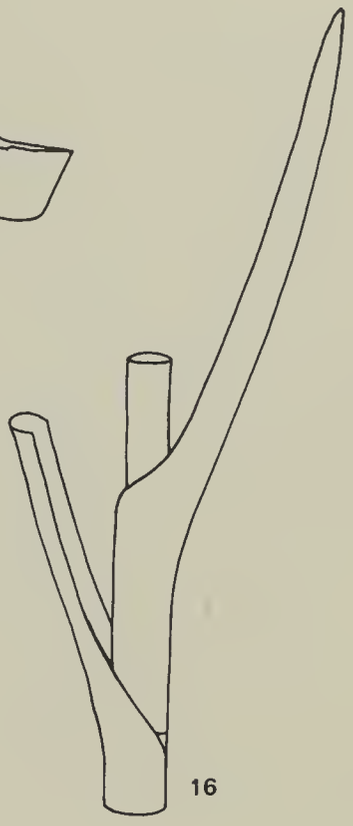

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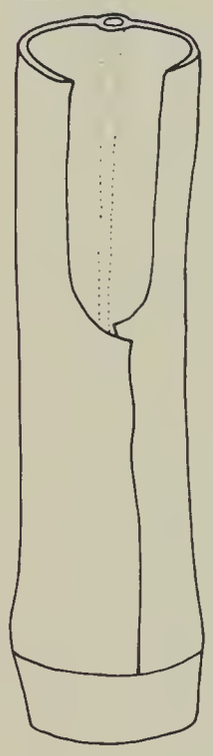

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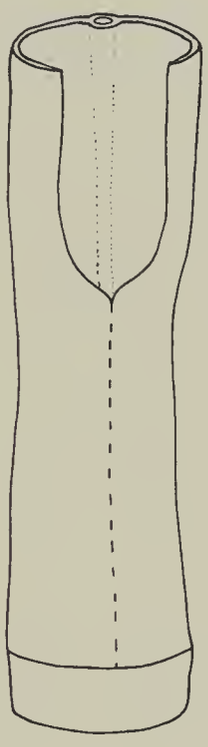

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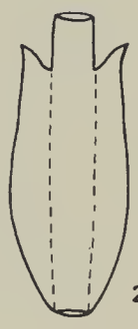

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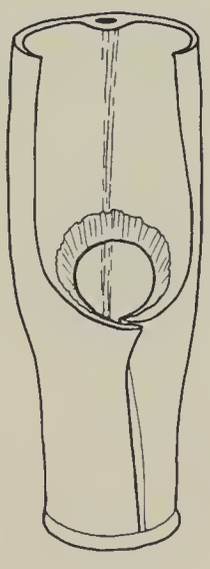

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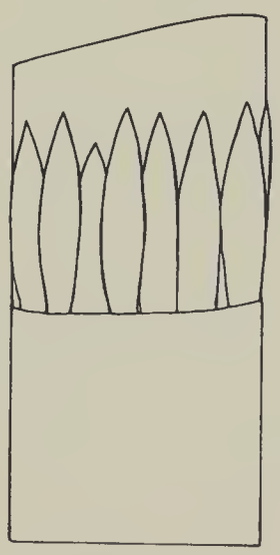

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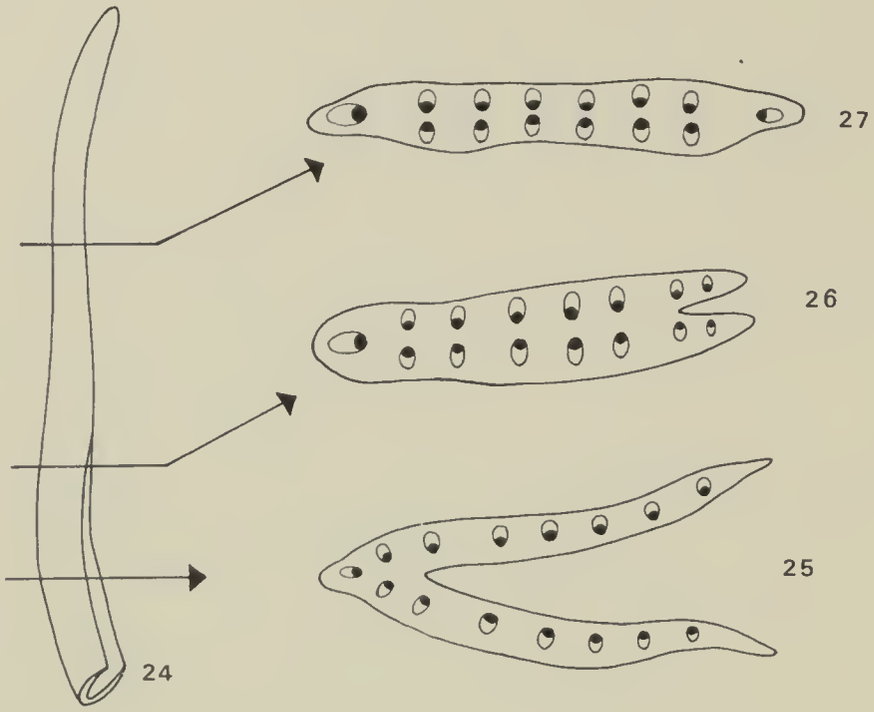

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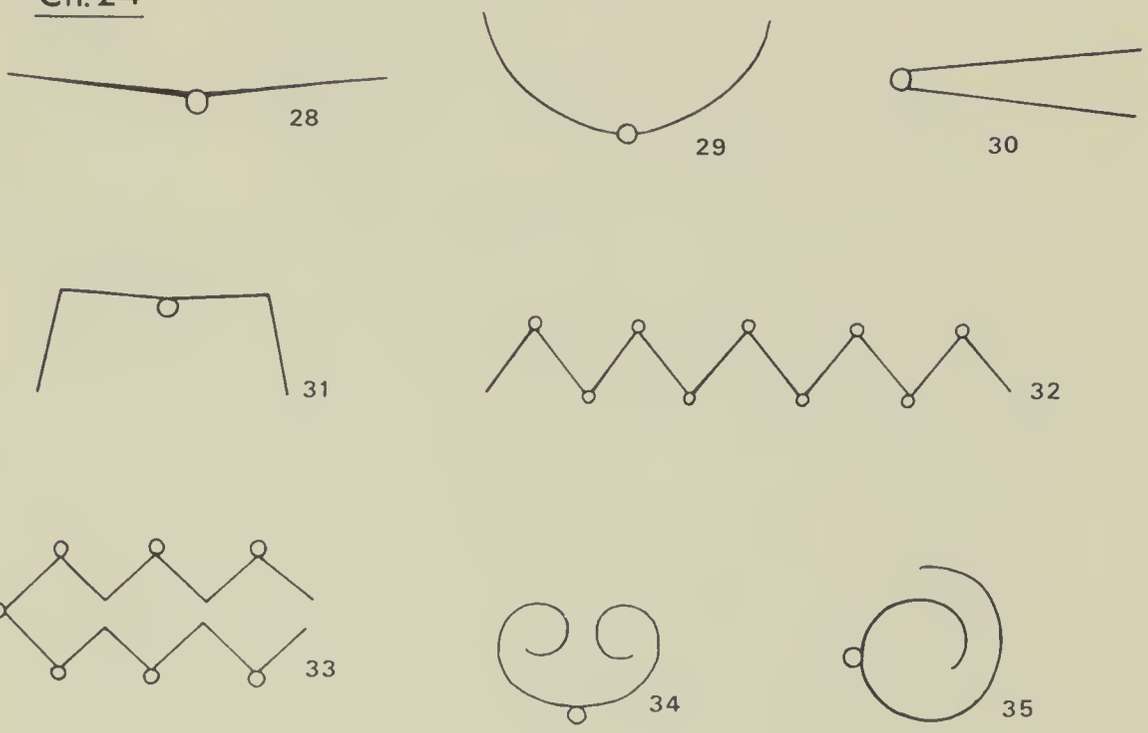

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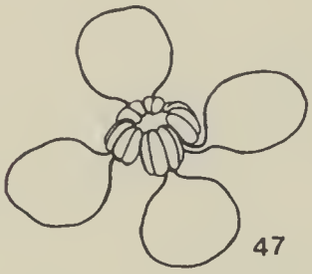
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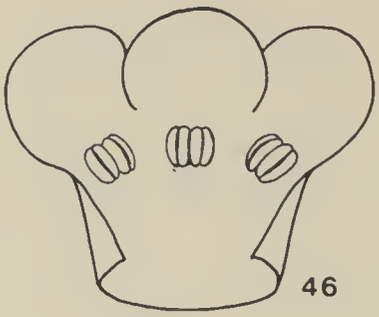
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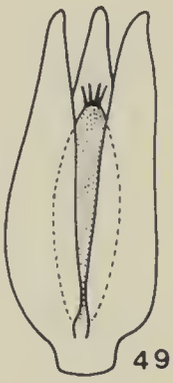
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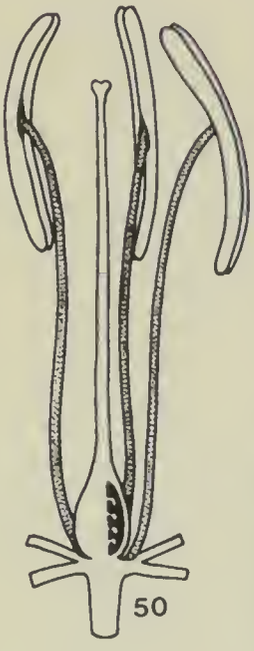
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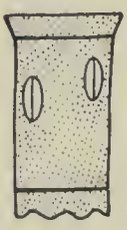
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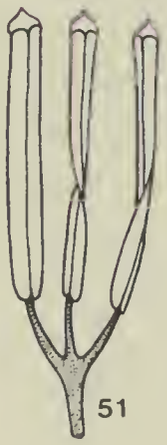
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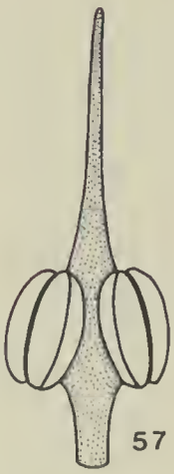
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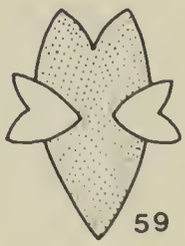
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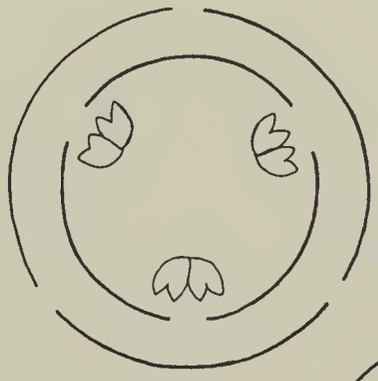
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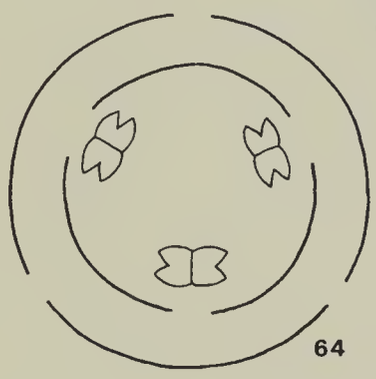
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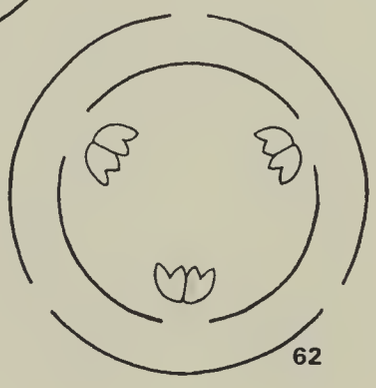
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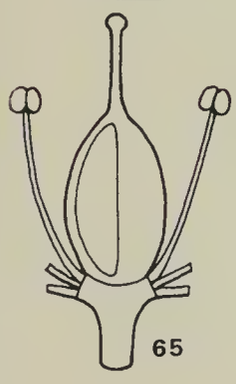
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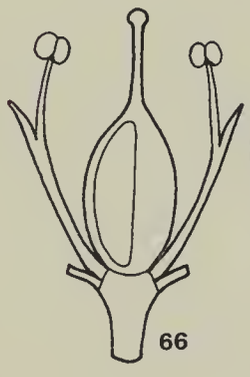
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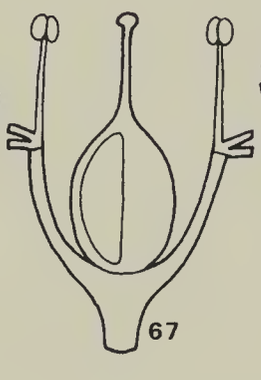
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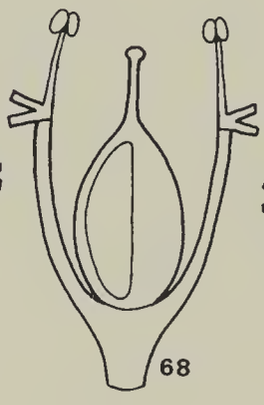
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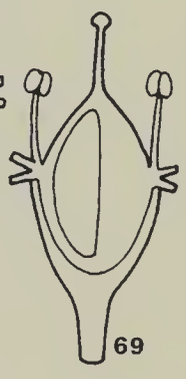
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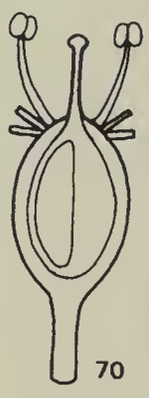
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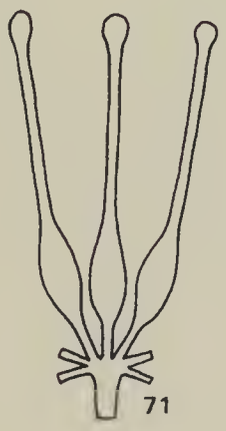
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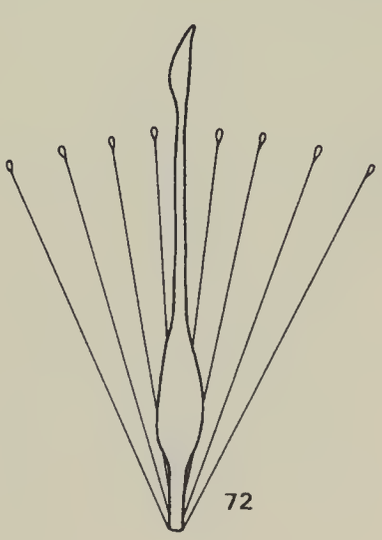
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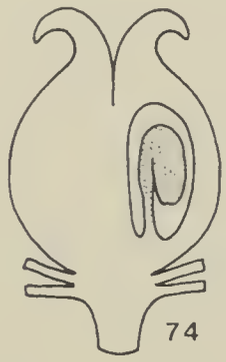
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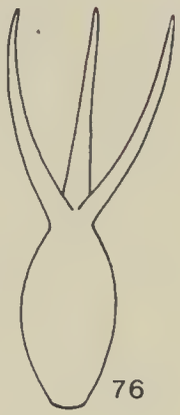
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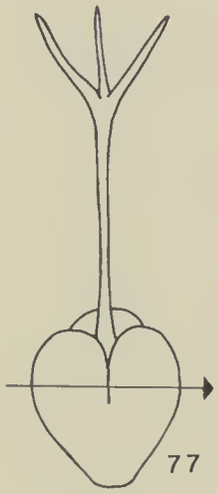
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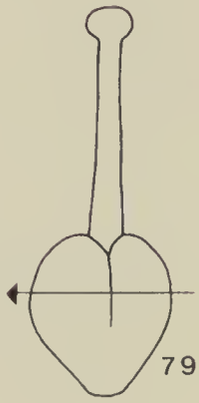
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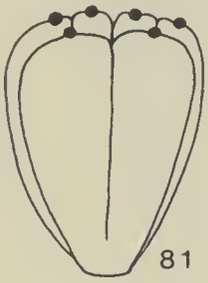
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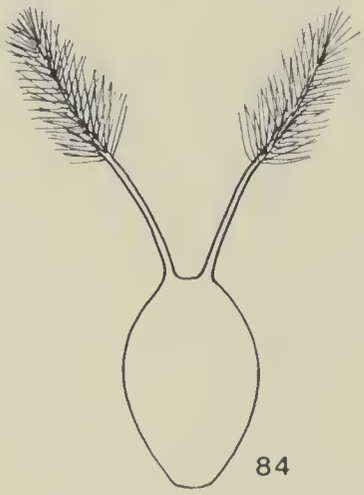
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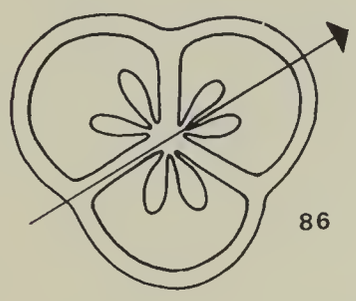
Ch. 60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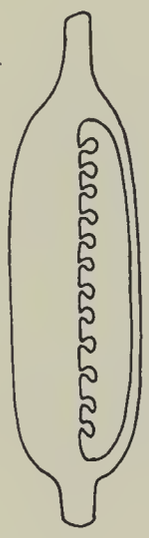
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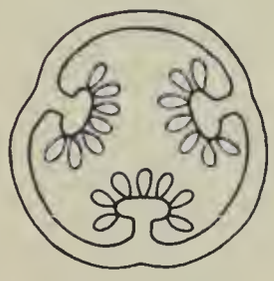
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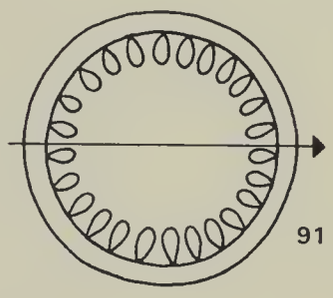
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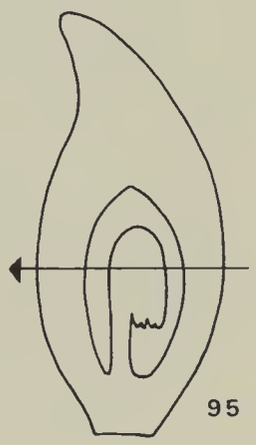
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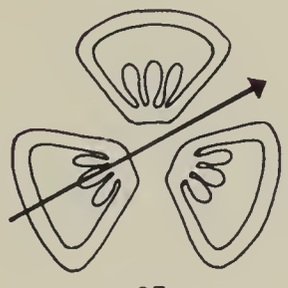
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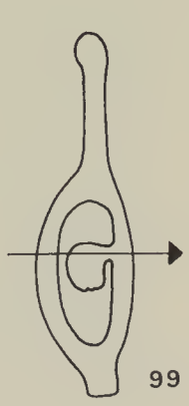
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APPENDIX II

Hutchinson's vs other systems of classification of Monocotyledones

There are about 255 names of monocotyledonous families published, most of which are indicated in Table 1. It is impossible to support all these families in any system of classification. The number of families recognised in different systems varies from 34 (Bentham & Hooker, 1883) to 98 (Dahlgren & Rasmussen, 1983). The differences in the delimitation of families between Hutchinson's (1973) and other popular or recent systems are summarised here.

BENTHAM & HOOKER (1883):
Number of families recognised: 34
Families recognised by Bentham & Hooker but not by Hutchinson: Scitamineae
Families recognised by Hutchinson (1973) but not by Bentham & Hooker:

Hutchinson	Bentham & Hooker
Butomaceae	in Alismataceae
Scheuchzeriaceae	in Naiadaceae
Petrosaviaceae	in Liliaceae
Juncaginaceae	in Naiadaceae
Liliaceae	in Naiadaceae
Posidoniaceae	in Naiadaceae
Aponogetonaceae	in Naiadaceae
Zosteraceae	in Naiadaceae
Potamogetonaceae	in Naiadaceae
Ruppiaceae	in Naiadaceae
Zannichelliaceae	in Naiadaceae
Cartonemataceae	in Commelinaceae
Musaceae	in Scitamineae
Strelitziaceae	in Scitamineae
Lowiaceae	in Scitamineae
Zingiberaceae	in Scitamineae
Cannaceae	in Scitamineae
Marantaceae	in Scitamineae
Techophilaeaceae	in Haemodoraceae
Trilliaceae	in Liliaceae
Smilacaceae	in Liliaceae
Ruscaceae	in Liliaceae
Alstroemeriaceae	in Amaryllidaceae
Petermanniaceae	in Dioscoreaceae
Philesiaceae	in Liliaceae
Sparganiaceae	in Typhaceae
Stenomeridaceae	in Dioscoreaceae
Trichopodaceae	in Dioscoreaceae
Xanthorrhoeaceae	in Juncaceae
Agavaceae	in Lilliaceae and Amaryllidaceae
Hypoxidaceae	in Amaryllidaceae
Velloziaceae	in Amarylidaceae
Apostasiaceae	in Orchidaceae
Thismiaceae	in Burmanniaceae
Corsiaceae	in Burmanniaceae
Thurniaceae	in Juncaceae

Because of these differences, the delimitation of the following families in the two systems is not identical:

Alismataceae, Naiadaceae (Najadaceae), Commelinaceae, Lilliaceae, Typhaceae, Amaryllidaceae, Dioscoreaceae, Haemodoraceae, Burmanniaceae, Orchidaceae and Juncaceae.

MELCHIOR (ENGLER'S) (1964)
Number of families recognised: 53
Families recognised by Melchior but not by Hutchinson:

Melchior	Hutchinson
Cyanastraceae	in Techophilaeaceae
Geosiridaceae	in Burmanniaceae (?)

Families recognised by Hutchinson but not by Melchior:

Hutchinson	Melchior
Petrosaviaceae	in Liliaceae
Lilaeaceae	in Juncaginaceae
Posidoniaceae	in Potamogetonaceae
Zosteraceae	in Potamogetonaceae
Ruppiaceae	in Potamogetonaceae
Cartonemataceae	in Commelinaceae
Strelitziaceae	in Musaceae
Tecophilaeaceae	in Haemodoraceae
Trilliaceae	in Liliaceae
Smilacaceae	in Liliaceae
Ruscaceae	in Liliaceae
Alstroemeriaceae	in Liliaceae
Petermanniaceae	in Liliaceae
Philesiaceae	in Liliaceae
Stenomeridaceae	in Dioscoreaceae
Trichopodaceae	in Dioscoreaceae
Apostasiaceae	in Orchidaceae
Thismiaceae	in Burmanniaceae

Because of these differences, the delimitation of the following families in the two systems is not identical:
Juncaginaceae, Potamogetonaceae, Commelinaceae, Musaceae, Liliaceae, Dioscoreaceae, Haemodoraceae, Burmanniaceae and Orchidaceae.

TAKHTAJAN (1980)
Number of families recognised: 77
Families recognised by Takhtajan but not by Hutchinson:

Takhtajan	Hutchinson
Limnocharitaceae	in Butomaceae
Cymodoceaceae	in Zannichelliaceae
Colchicaceae	in Liliaceae
Herreriaceae	in Liliaceae
Alliaceae	in Amaryllidaceae
Hemerocallidaceae	in Liliaceae
Phormiaceae	in Agavaceae
Doryanthaceae	in Agavaceae
Asphodelaceae	in Liliaceae
Aphyllanthaceae	in Liliaceae
Hanguanaceae	in Flagellariaceae
Asparagaceae	in Liliaceae
Dracaenaceae	in Agavaceae
Joinvilleaceae	in Flagellariaceae
Ecdeiocoleaceae	in Restionaceae
Hydatellaceae	in Centrolepidaceae
Heliconiaceae	in Strelitziaceae
Costaceae	in Zingiberaceae

Families recognised by Hutchinson but not by Takhtajan:

Hutchinson	Takhtajan
Petrosaviaceae	in Colchicaceae
Lilaeaceae	in Juncaginaceae
Cartonemataceae	in Commelinaceae
Ruscaceae	in Asparagaceae
Petermanniaceae	in Philesiaceae
Sparganiaceae	in Typhaceae
Stenomeridaceae	in Dioscoreaceae
Trichopodaceae	in Dioscoreaceae
Apostasiaceae	in Orchidaceae
Thismiaceae	in Burmanniaceae

Because of these differences, the delimitation of the following families in the two systems is not identical:

Butomaceae, Juncaginaceae, Zannichelliaceae, Commelinaceae, Flagellariaceae, Strelitziaceae, Zingiberaceae, Liliaceae, Philesiaceae, Typhaceae, Amaryllidaceae, Dioscoreaceae, Agavaceae, Burmanniaceae, Orchidaceae, Centrolepidaceae and Restionaceae. In addition, Takhtajan included Geosiridaceae in the Iridaceae.

CRONQUIST (1981)

Number of families recognised: 65

Families recognised by Cronquist but not by Hutchinson:

Cronquist	Hutchinson
Limnocharitaceae	in Butomaceae
Cymodoceaceae	in Zannichelliaceae
Joinvilleaceae	in Flagellariaceae
Hydatellaceae	in Centrolepidaceae
Heliconiaceae	in Strelitziaceae
Costaceae	in Zingiberaceae
Cyanastraceae	in Tecophilaeaceae
Aloeaceae	in Liliaceae
Hanguanaceae	in Flagellariaceae
Geosiridaceae	in Burmanniaceae (?)

Families recognised by Hutchinson but not by Cronquist:

Hutchinson	Cronquist
Lilaeaceae	in Juncaginaceae
Cartonemataceae	in Commelinaceae
Tecophilaeaceae	in Liliaceae
Trilliaceae	in Liliaceae
Ruscaceae	in Liliaceae
Alstroemeriaceae	in Liliaceae
Petermanniaceae	in Smilacaceae
Philesiaceae	in Liliaceae
Amaryllidaceae	in Liliaceae
Stenomeridaceae	in Dioscoreaceae
Trichopodaceae	in Dioscoreaceae
Hypoxidaceae	in Liliaceae
Apostasiaceae	in Orchidaceae
Thismiaceae	in Burmanniaceae

Because of these differences, the delimitation of the following families in the two systems is not identical:

Butomaceae, Juncaginaceae, Zannichelliaceae, Commelinaceae, Flagellariaceae, Strelitziaceae, Zingiberaceae, Liliaceae, Smilacaceae, Dioscoreaceae, Burmanniaceae, Orchidaceae and Centrolepidaceae.

DAHLGREN & CLIFFORD (1982)

Number of families recognised: 97

Families recognised by Dahlgren & Clifford but not by Hutchinson:

Dahlgren & Clifford	Hutchinson
Cymodoceaceae	in Zannichelliaceae
Geitonoplesiaceae	in Philesiaceae
Convallariaceae	in Liliaceae
Asparagaceae	in Liliaceae
Herreriaceae	in Liliaceae
Dracaenaceae	in Agavaceae
Nolinaceae	in Agavaceae
Doryanthaceae	in Agavaceae
Hanguanaceae	in Flagellariaceae
Dasypogonaceae	in Liliaceae
Cyanastraceae	in Tecophilaeaceae
Phormiaceae	in Agavaceae
Dianellaceae	in Liliaceae
Eriospermaceae	in Liliaceae
Asteliaceae	in Liliaceae
Aphyllanthaceae	in Liliaceae
Anthericaceae	in Liliaceae
Asphodelaceae	in Liliaceae
Hemerocallidaceae	in Liliaceae
Funkiaceae	in Liliaceae
Hyacinthaceae	in Liliaceae
Alliaceae (incl. Agapanthaceae and Gilliesiaceae)	in Amaryllidaceae
Colchicaceae	in Liliaceae
Geosiridaceae	in Burmanniaceae (?)
Calochortaceae	in Liliaceae
Tricyrtidaceae	in Liliaceae
Melanthiaceae	in Liliaceae
Campynemataceae	in Hypoxidaceae
Cyprepediaceae	in Orchidaceae
Heliconiaceae	in Strelitziaceae
Costaceae	in Zingiberaceae
Hydatellaceae	in Centrolepidaceae
Joinvilleaceae	in Flagellariaceae

Families recognised by Hutchinson but not by Dahlgren & Clifford:

Hutchinson	Dahlgren & Clifford
Petrosaviaceae	in Melanthiaceae
Lilaeaceae	in Juncaginaceae
Ruppiaceae	in Potamogetonaceae
Cartonemataceae	in Commelinaceae
Petermanniaceae	in Smilacaceae

In addition, Dahlgren & Clifford included the Limnocharitaceae in the Alismataceae.

Because of these differences, the delimitation of the following families in the two systems is not identical:

Butomaceae, Alismataceae, Juncaginaceae, Potamogetonaceae, Zannichelliaceae, Commelinaceae, Flagellariaceae, Strelitziaceae, Zingiberaceae, Liliaceae, Tecophilaeaceae, Smilacaceae, Philesiaceae, Amaryllidaceae, Agavaceae, Hypoxidaceae, Burmanniaceae, Orchidaceae and Centrolepidaceae.

DAHLGREN & RASMUSSEN (1983)

Number of families recognised: 98

This version is similar to that by Dahlgren & Clifford (1982) but for the following differences:

The Stenomeridaceae were included in the Dioscoreaceae and Dianellaceae in the Phormiaceae;

Petermanniaceae were separated from Smilacaceae, Luzuriagaceae from Philesiaceae and Ixioliriaceae from Asphodelaceae. Consequently, in addition to the families already mentioned under Dahlgren & Clifford above, the delimitation of the Dioscoreaceae also is not identical with that in Hutchinson's system (1973).

APPENDIX III

Alphabetical list of Monocotyledonous families and their punch positions on cards

All the families recognised in the current systems of classification of Monocotyledones discussed in Appendix II are listed here. The families that are not recognised in the polyclave are indicated by an asterisk (*); the punch position shown against them refer to the families that include them. The families in this polyclave are indicated by the serial numbers.

S. No.	Family	Punch position
	Agapanthaceae*	53
1	Agavaceae	60
2	Alismataceae	13
	Alliaceae*	53
	Aloeaceae*	40
3	Alstroemeriaceae	46
4	Amaryllidaceae	53
	Anthericaceae*	40
	Aphyllanthaceae*	40
5	Aponogetonaceae	20
6	Apostasiaceae	67
7	Araceae	49
8	Arecaceae (Palmae)	61
	Asparagaceae*	40
	Asphodelaceae*	40
	Asteliaceae*	40
9	Bromeliaceae	33
10	Burmanniaceae	70
11	Butomaceae	11
	Calochortaceae*	40
	Campynemataceae*	65
12	Cannaceae	38
13	Cartonemataceae	27
14	Centrolepidaceae	76
	Colchicaceae*	40
15	Commelinaceae	26
	Convallariaceae*	40
16	Corsiaceae	72
	Costaceae*	37
	Cyanastraceae*	41
17	Cyclanthaceae	63
	Cymodoceaceae*	24
18	Cyperaceae	78
	Cyprepediaceae*	73
	Dasypogonaceae*	40
	Dianellaceae*	40
19	Dioscoreaceae	58
	Doryanthaceae*	60
	Dracaenaceae*	60
	Ecdeiocoleaceae*	77
20	Eriocaulaceae	32
	Eriospermaceae*	40

S. No.	Family	Punch position
21	Flagellariaceae	28
	Funkiaceae*	40
	Geitonoplesiaceae*	48
	Geosiridaceae*	70
	Gilliesiaceae*	53
	Gramineae (Poaceae)	79
22	Haemodoraceae	64
	Hanguanaceae*	28
	Heliconiaceae*	35
	Hemerocallidaceae*	40
	Herreriaceae*	40
	Heterostylaceae (Lilaeaceae)	18
	Hyacinthaceae*	40
	Hydatellaceae*	76
23	Hydrocharitaceae	12
24	Hypoxidaceae	65
25	Iridaceae	54
	Ixioliriaceae*	40
	Joinvilleaceae*	28
26	Juncaceae	74
27	Juncaginaceae	17
28	Lemnaceae	50
29	Lilaeaceae (Heterostylaceae)	18
30	Liliaceae	40
	Limnocharitaceae*	11
31	Lowiaceae	36
	Luzuriagaceae*	48
32	Marantaceae	39
33	Mayacaceae	29
	Melanthaceae*	40
34	Musaceae	34
35	Najadaceae	25
	Nolinaceae*	60
36	Orchidaceae	73
	Palmae (Arecaceae)	61
37	Pandanaceae	62
38	Petermanniaceae	47
39	Petrosaviaceae	15
40	Philesiaceae	48
	Phormiaceae*	60
41	Phylidraceae	69
42	Poaceae (Gramineae)	79

S. No.	Family	Punch position
43	Pontederiaceae	43
44	Posidoniaceae	19
45	Potamogetonaceae	22
46	Rapateaceae	31
47	Restionaceae	77
48	Roxburghiaceae	57
49	Ruppiaceae	23
50	Ruscaceae	45
51	Scheuchzeriaceae	14
	Scitamineae*	34—39
52	Smilacaceae	44
53	Sparganiaceae	51
54	Stenomeridaceae	55
55	Strelitziaceae	35
56	Taccaceae	68
57	Tecophilaeaceae	41
58	Thismiaceae	71
59	Thurniaceae	75
60	Trichopodaceae	56
	Tricyrtidaceae*	40
61	Trilliaceae	42
62	Triuridaceae	16
63	Typhaceae	52
64	Velloziaceae	66
65	Xanthorrhoeaceae	59
66	Xyridaceae	30
67	Zannichelliaceae	24
68	Zingiberaceae	37
69	Zosteraceae	21

APPENDIX IV

Alphabetical list of countries, territories, archipelagos and major islands

The name of the country, territory, archipelago or island, its phytogeographical position and the serial number of the relevant card are given. Details of phytogeographic units are given in Table 4. Alternate names of the territories or the countries to which they are affiliated, are shown in parenthesis. The asterisk (*) indicates localities served by the international postal network.

Name	Phytogeographic area	Card number
*Açores (Portugal)	Tethyan	7603
Adamstown group of Is (UK)	Fiji-Polyn.	7709
*Afghanistan	Tethyan	7603
	African	7703
Alaska (USA)	Circumboreal	7601
*Albania	Circumboreal	7601
Aleutian Is (Alaska, USA)	Circumboreal	7601
*Algeria	Tethyan	7603
Alofi (Niue) I. (New Zealand)	Fiji-Polyn.	7709
Amami Archipelago (Ryukyu Is)	E. Asiatic	7604
American Somoa (USA)	Fiji-Polyn.	7709
Andaman & Nicobar Is (India)	Indochinese	7707
Andes, central & northern	Neotropical	7702
Andes, southern	Antarctic	7605
*Andorra	Tethyan	7603
*Angola (Cabinda)	African	7703
*Anguila	Neotropical	7702
Antarctic main land, peninsula and islands	Antarctic	7605
*Antigua (UK)	Neotropical	7702
Arctic coast & islands	Circumboreal	7601
*Argentina	Antarctic	7605,
	Neotropical	7702
*Ascension I. (UK)	African	7703
Assam, eastern (India)	Indochinese	7707
Atlantic European coast	Circumboreal	7601
Atlantic South American coast	Neotropical	7702
Atlantic gulf coastal plain	Atl. N. Amer.	7602
Auckland I. (New Zealand)	Antarctic	7605
*Australia	Australian	7711
*Austria	Circumboreal	7601
*Azores (Açores)	Tethyan	7603
*Bahama Is (W. Indies)	Neotropical	7702
*Bahrein, State of	Tethyan	7603
Baker I. (USA)	Fiji-Polyn.	7709
*Balearic Is	Tethyan	7603
Bali (Indonesia)	Malesian	7708
Balls Pyramid (Australia)	Antarctic	7605
Baluchisthan, north	Tethyan	7603
Baluchisthan, south	African	7703
*Bangla Desh	Indian	7706

Name	Phytogeographic area	Card number
*Barbados	Neotropical	7702
Bassas da India (France)	African	7703
*Belgium	Circumboreal	7601
*Belize	Neotropical	7702
*Benin, People's Repub. of (Dahomey)	African	7703
*Bermuda Is (UK) (W. Indies)	Neotropical	7702
*Bhutan	E. Asiatic	7604
Bijagos Archipelago (Guinea-Bissau)	African	7703
Bismarck Archipelago	Malesian	7708
Black Rock (UK)	Antarctic	7605
*Bolivia	Neotropical	7702
Bonaparte Archipelago (Australia)	Australian	7711
Bonin (Ogaswara Gunto) Is (Japan)	E. Asiatic	7604
Borneo (Kalimantan)	Malesian	7708
*Botswana (Bechuanaland)	African	7703
Bougainville I. (Solomon Is) (Papua New Guinea)	Fiji-Polyn.	7709
Bourkina Fasso (Upper Volta)	African	7703
*Brazil	Neotropical	7702,
	Antarctic	7605
British Antarctic Territory	Antarctic	7605
British Indian Ocean Territory	Indian	7706
*British Virgin Is	Neotropical	7702
*Brunei	Malesian	7708
*Bulgaria	Tethyan	7603
Burma, northern	E. Asiatic	7604
*Burma, southern	Indochinese	7707
*Burundi	African	7703
Caicos I. (UK)	Neotropical	7702
Californian province	Madrean	7701
*Cameroun (Cameroon) United Repub. of	African	7703
Campbell I. (New Zealand)	Antarctic	7605
*Canada	Circumboreal	7601
*Canary Is (Spain)	Tethyan	7603
Canton I. (Phoenix Is) (UK & USA)	Fiji-Polyn.	7709
*Cape Verde Is	Tethyan	7603
*Caroline Is (USA Trust)	Fiji-Polyn.	7709
Carondelet Reef (Phoenix Is)	Fiji-Polyn.	7709
Cartier I. (Australian)	Malesian	7708
*Cayman Is (UK)	Neotropical	7702
*Central African Republic	African	7703
*Chad, Repub. of	Tethyan	7603,
	African	7703
Chagos Archipelago (UK)	Indian	7706
Chatham Is (New Zealand)	Antarctic	7605
*Chetumal (Mexico)	Neotropical	7702
*Chile	Antarctic	7605,
	Neotropical	7702
*China	E. Asiatic	7604,
	Indochinese	7707
Christmas I. (Australia)	Malesian	7708
*Christmas I. (Kiribati Is)	Fiji-Polyn.	7709
*Cocos (Keeling) Is (Australia)	Malesian	7708
*Colombia	Neotropical	7702
*Comoro Is (Comores)	Madagascan	7705
*Congo (Brazzaville), People's Repub. of	African	7703
Congo, Kinshasa (Zaire)	African	7703

Name	Phytogeographic area	Card number
Cook Is (New Zealand)	Fiji-Polyn.	7709
Coral Sea Is Territory (Australia)	Fiji-Polyn.	7709
*Corsica	Tethyan	7603
*Costa Rica	Neotropical	7702
Crete (Kriti) (Greece)	Tethyan	7709
*Cuba	Neotropical	7702
Curacao (Netherlands)	Neotropical	7702
*Cyprus	Tethyan	7603
*Czechoslovakia	Circumboreal	7601
Dahomey (Benin)	African	7703
Deccan (India)	Indian	7706
*Denmark	Circumboreal	7601
Diego Garcia (UK)	Indian	7706
*Djibouti (French Somaliland)	African	7703
*Dominica	Neotropical	7702
*Dominican Republic	Neotropical	7702
Easter I. (Rapa Nui) (Chile)	Antarctic	7605
East Indies	Malesian	7708
*East Timor (Indonesia)	Malesian	7708
*Ecuador	Neotropical	7702
*Egypt (Misra), Arab Repub. of	Tethyan	7603
Ellis (ce) Is (Tuvalu)	Fiji-Polyn.	7709
*El Salvador	Neotropical	7702
*Equatori-Guinea	African	7703
*Ethiopia	African	7703
Europa I. (France)	Madagascan	7705
*Falkland Is (UK)	Antarctic	7605
Fanning I. (Kiribati Is)	Fiji-Polyn.	7709
*Faeroe Is (Denmark)	Circumboreal	7601
Fernando Poo (Equatori Guinea)	African	7703
*Fiji Is	Fiji-Polyn.	7709
*Finland	Circumboreal	7601
Flores (Indonesia)	Malesian	7708
*France	Circumboreal Tethyan	7601, 7603
*French Guiana	Neotropical	7702
*French Polynesia	Fiji-Polyn.	7709
French southern & Antarctic lands	Antarctic	7605
Friendly (Tonga) Is	Fiji-Polyn.	7709
Furneaux group Is (Australia)	Australian	7711
*Gabon, Repub. of	African	7703
Galapagos Archipelago (Ecuador)	Neotropical	7702
*Gambia, Repub. of	African	7703
Gambier Is (France)	Fiji-Polyn.	7709
Gangetic plain (India)	Indian	7706
*Gaza & Khan Yunis	Tethyan	7603
*Germany, (East) Democ. Repub. of	Circumboreal	7601
*Germany, (West) Fed. Repub. of	Circumboreal	7601
*Ghana (Gold Coast)	African	7703
*Gibraltar (UK)	Tethyan	7603
Gilbert Is	Fiji-Polyn.	7709
Gold Coast (Ghana)	African	7703

Name	Phytogeographic area	Card number
Gough I. (UK)	Antarctic	7605
*Greece	Circumboreal	7601,
	Tethyan	7603
*Greenland (Denmark)	Circumboreal	7601
*Grenada	Neotropical	7702
*Guam (USA)	Fiji-Polyn.	7709
*Guatemala	Neotropical	7702
*Guinea, Repub. of	African	7703
*Guinea-Bissau, Repub. of	African	7703
*Guyana	Neotropical	7702
Ha'apai group Is	Fiji-Polyn.	7709
Hainan Tao (China)	Indochinese	7707
*Haiti	Neotropical	7702
Hawaiian Is (USA)	Fiji-Polyn.	7709
Heard & MacDonald Is (Australia)	Antarctic	7605
Hebrides (UK)	Circumboreal	7601
Henderson I.	Fiji-Polyn.	7709
Himalayas, eastern	E. Asiatic	7604
Himalayas, western	Tethyan	7603
*Honduras	Neotropical	7702
*Hong Kong (UK)	E. Asiatic	7604
Howland I. (USA)	Fiji-Polyn.	7709
*Hungary	Circumboreal	7601
*Iceland	Circumboreal	7601
Ile of Amsterdam (France)	Antarctic	7605
Ile Saint Paul (France)	Antarctic	7605
Ile Tromolin (Mascarenes) (France)	Madagascan	7705
Iles Chesterfield (France)	Fiji-Polyn.	7709
Iles de la Societe (France)	Fiji-Polyn.	7709
Iles des Tuamotu (France)	Fiji-Polyn.	7709
Iles du Crozet (France)	Antarctic	7605
Iles du Desappointment (France)	Fiji-Polyn.	7709
Iles du Duc de Gloucester (Tuamotu) (France)	Fiji-Polyn.	7709
Iles du Gambler (Tuamotu) (France)	Fiji-Polyn.	7709
Iles de Vent (Societe Is) (France)	Fiji-Polyn.	7709
Iles Kerguelen (France)	Antarctic	7605
Iles Marquises (France)	Fiji-Polyn.	7709
Iles des Pins	Neocaledonian	7710
Iles sous le Vent (Societe) (France)	Fiji-Polyn.	7709
Iles Tubuai ou Australes (France)	Fiji-Polyn.	7709
Iles Wallis et Futuna (France)	Fiji-Polyn.	7709
*India	Tethyan	7603,
	E. Asiatic	7604,
	African	7703,
	Indian	7706,
	Indochinese	7707
*Indonesia	Malesian	7708
*Iran	Tethyan	7603
*Iraq	Tethyan	7603
*Ireland, Repub. of	Circumboreal	7601
Irian Jaya (Indonesia)	Malesian	7708
Islas Revilla Gigedo (Mexico)	Neotropical	7702
*Israel	Tethyan	7603

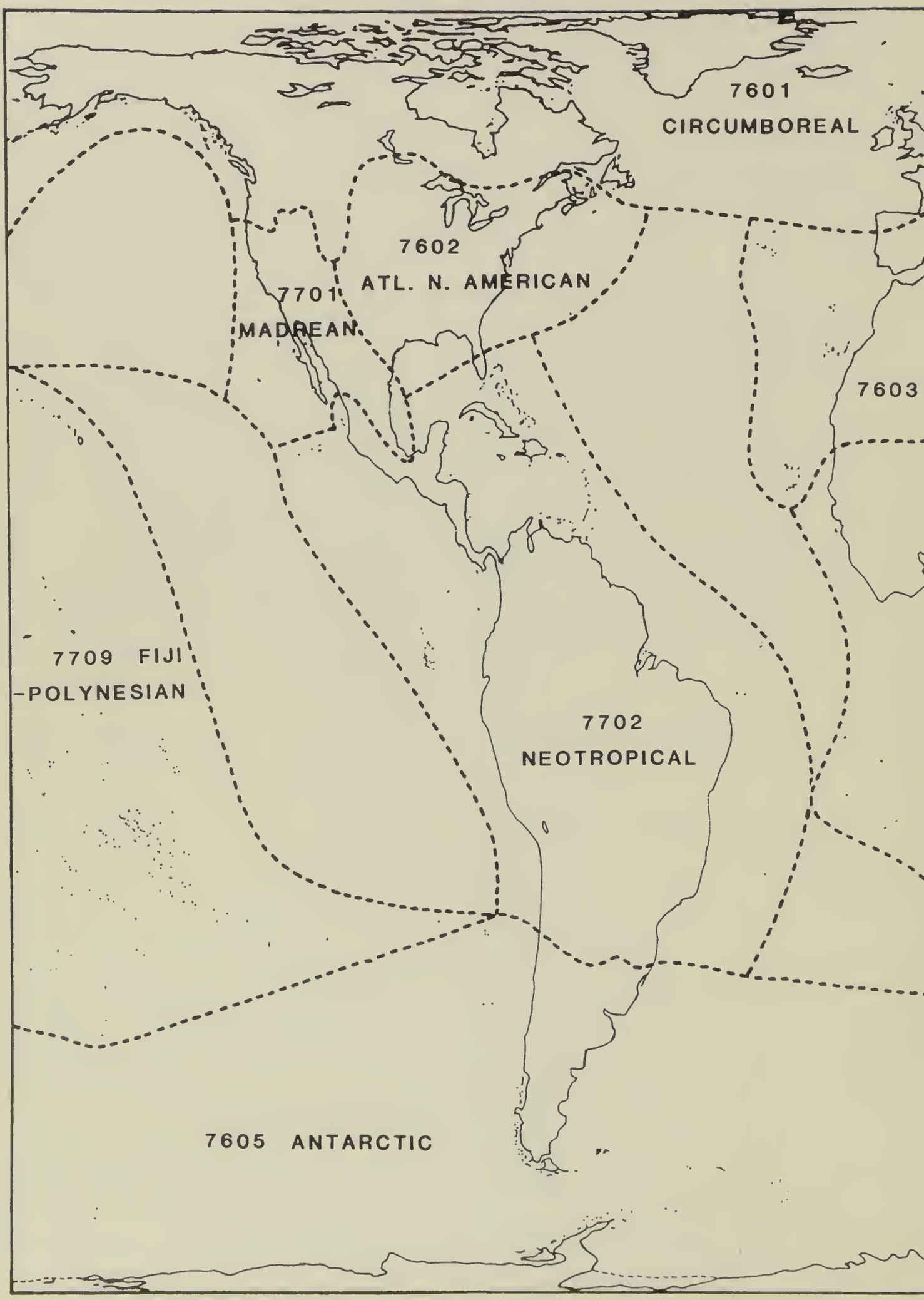
Name	Phytogeographic area	Card number
*Italy	Circumboreal	7601,
	Tethyan	7603
*Ivory Coast	African	7703
*Jamaica	Neotropical	7702
*Japan	E. Asiatic	7604
Jarvis I. (USA)	Fiji-Polyn.	7709
Java (Indonesia)	Malesian	7708
*Jordan	Tethyan	7603
Juan Fernandez Is (Chile)	Antarctic	7605
Kalimantan (Borneo) (Indonesia)	Malesia	7708
*Kampuchea (Cambodia)	Indochinese	7707
Keeling (Cocos) Is (Australia)	Malesia	7708
*Kenya	African	7703
Kermadec Is (New Zealand)	Antarctic	7605
Khasi-Manipur (India)	E. Asiatic	7604
*Kiribati, Repub. of (Phoenix Is)	Fiji-Polyn.	7709
Kokos I. (Costa Rica)	Neotropical	7702
Korea, North	E. Asiatic	7604
*Korea, Repub. of, South	E. Asiatic	7604
Kurilskiye Ostrova (USSR)	E. Asiatic	7604
*Kuwait	Tethyan	7603
Lakkadive (Laksha dweep) Is (India)	Indian	7706
*Laos People's Democ. Repub. of	Indochinese	7707
Lau group Is	Fiji-Polyn.	7709
*Lebanon	Tethyan	7603
Leeward Is	Neotropical	7702
*Lesotho (Basutoland)	African	7703
Lesser Antilles	Neotropical	7702
Lesser Sunda Is	Malesian	7708
*Liberia, Repub. of	African	7703
*Libya, Soc. Peoples' Arab Jamahiriya	Tethyan	7603
Line (Kiribati) Is	Fiji-Polyn.	7709
Lombok (Indonesia)	Malesian	7708
Lord Howe I. (Australia)	Antarctic	7605
Louisiade Archipelago	Malesian	7708
Loyalty Is	Neocaledonian	7710
*Luxemberg (-bourg)	Circumboreal	7601
*Macao (Portugal)	E. Asiatic	7604
Macquarie Is (Australia)	Antarctic	7605
Macronesia	Tethyan	7603
Madagascar, (Malagasy) Democ. Repub. of	Madagascan	7705
*Madeira (Portugal)	Tethyan	7603
Malabar (India)	Indian	7706
Malacca	Malesian	7708
*Malawi	African	7703
Malay Peninsula (Malaysia)	Malesian	7708
*Malaysia	Malesian	7708
*Maldives, Repub. of	Indian	7706
Mali	Tethyan	7603,
	African	7703
*Malta	Tethyan	7603
Manchuria	E. Asiatic	7604

Name	Phytogeographic area	Card number
Manipur (India)	E. Asiatic	7604
*Mariana Is (Ladrones) (USA Trust)	Fiji-Polyn.	7709
Marion I. (S. Africa)	Fiji-Polyn.	7709
*Marshall Is (USA Trust)	Fiji-Polyn.	7709
Martin Vaz (Brazil)	Neotropical	7702
Mascarenes	Madagascan	7705
*Mauritania	Tethyan	7603,
	African	7703
*Mauritius	Madagascan	7705
Mayotte I. (France)	Madagascan	7705
Mediterranean coast & Is	Tethyan	7603
Melanesian Is	Fiji-Polyn.	7709
*Mexico	Madrean	7701,
	Neotropical	7702
Micronesian Is (USA Trust)	Fiji-Polyn.	7709
Misra (Egypt)	Tethyan	7603
Molucca	Malesian	7708
Monaco	Tethyan	7603
*Mongolia, People's Repub. of	Tethyan	7603
*Montserrat (UK)	Neotropical	7702
*Morocco	Tethyan	7603
*Mozambique	African	7703
*Namibia (SW. Africa)	African	7703
*Nauru Is, Repub. of	Fiji-Polyn.	7709
*Nepal	E. Asiatic	7604
*Netherlands	Circumboreal	7601,
*Netherlands Antilles	Neotropical	7702
*Nevis (UK)	Neotropical	7702
*New Caledonian Is (France)	Neocaledonian	7710
New Hebrides Is	Fiji-Polyn.	7709
*New Zealand	Antarctic	7605,
*Nicaragua	Neotropical	7702
Nicobar Is (India)	Indochinese	7707
*Niger, Repub. of	Tethyan	7603
	African	7703
*Nigeria	African	7703
Niue (Nikugale) I. (New Zealand)	Antarctic	7605
*Norfolk I. (Australia)	Antarctic	7605
Noronha, Fernando, de (Brazil)	Neotropical	7702
*Norway	Circumboreal	7601,
Oceania (-ic Is)	Fiji-Polyn.	7709
Ogaswara Gunto (Bonin Is) (Japan)	E. Asiatic	7604
Okinawa	E. Asiatic	7604
*Oman, Sultanate of	Tethyan	7603,
	African	7703
Orkney Is (UK)	Circumboreal	7601
*Pakistan	Tethyan	7603,
	African	7703
Palmer I. (USA)	Antarctic	7605
Palmyra Atoll I. (Kiribati) (USA)	Fiji-Polyn.	7709
Pampea	Antarctic	7605
*Panama, Repub. of	Neotropical	7702
*Papua New Guinea	Malesian	7708
*Paraguay	Neotropical	7702

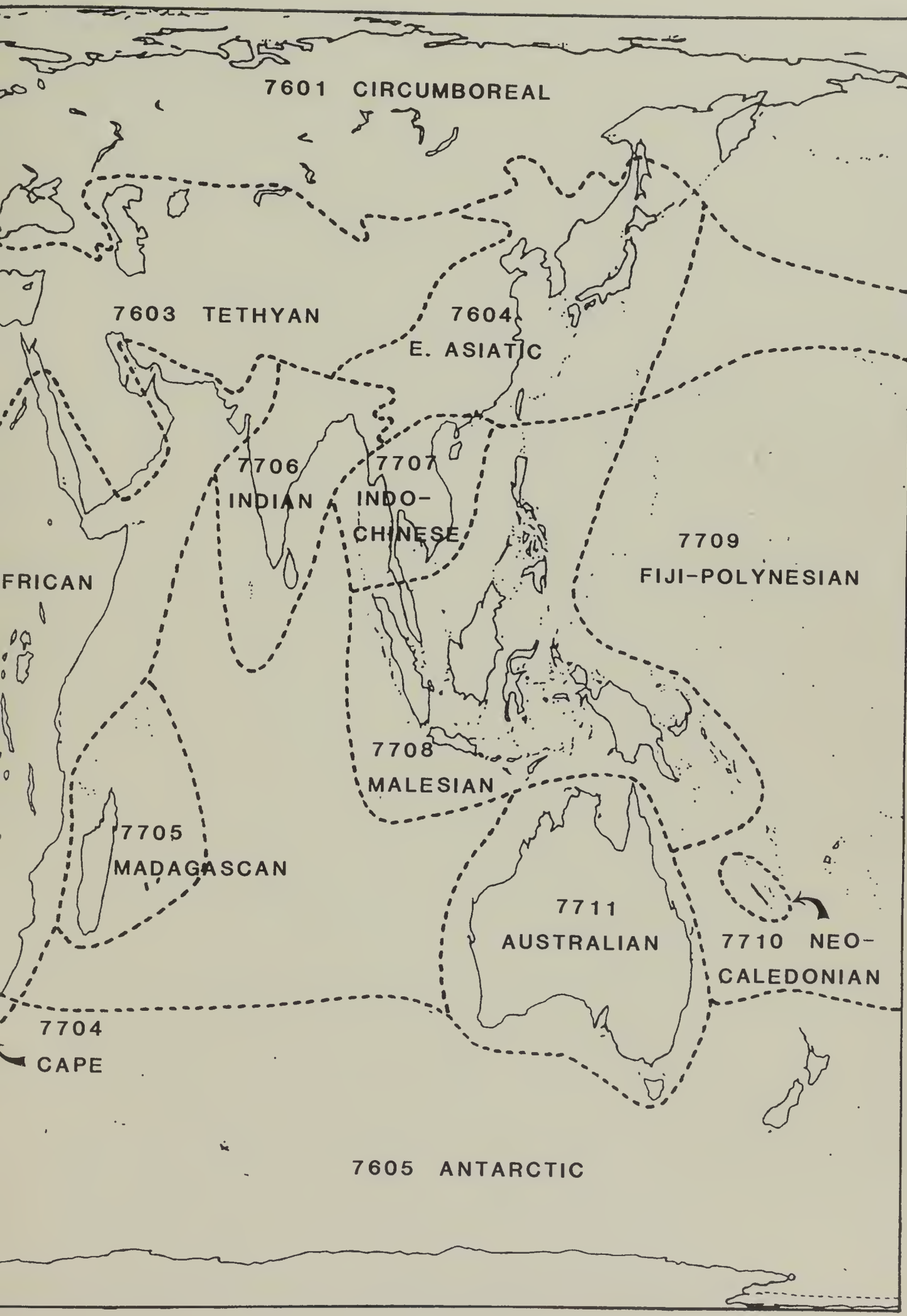
Name	Phytogeographic area	Card number
Pemba	African	7703
Peru	Neotropical	7702
Peter I. (Norway)	Antarctic	7605
*Philippines, Repub. of	Malesian	7708
*Phoenix Is (Kiribati)	Fiji-Polyn.	7709
*Pitcairn I. (UK)	Fiji-Polyn.	7709
*Poland	Circumboreal	7601
Polynesian Is	Fiji-Polyn.	7709
*Portugal	Tethyan	7603,
Pribilof Is (USA)	Circumboreal	7601
Prince Edward I. (Canada)	Circumboreal	7601
Prince Edward Is (S. Africa)	Antarctic	7605
Principé	African	7703
Providencia (Colombia)	Neotropical	7702
*Puerto Rico	Neotropical	7702
*Qatar, State of	Tethyan	7603
Rajasthan (India)	African	7703
Ralik group Is (Micronesia) (USA)	Fiji-Polyn.	7709
Rapa Nui (Easter) I. (Chile)	Antarctic	7605
Rarotong I. (New Zealand)	Fiji-Polyn.	7709
Ratak group Is (Micronesia) (USA)	Fiji-Polyn.	7709
*Reunion (France)	Madagascan	7705
Rio Muni	African	7703
Rochedos de Sao Pedro & Sao Paulo (Brazil)	Neotropical	7702
Rocky Mountains	Atl. N. Amer.	7602
Rodriguez I. (Mauritius)	Madagascan	7705
*Rumania	Circumboreal	7601
*Rwanda	African	7703
Ryukyu Is (Japan)	E. Asiatic	7604
Sabah (Malaysia)	Malesian	7708
Sahara, African	Tethyan	7603,
	African	7703
Sahara, Spanish (W. Sahara)	Tethyan	7603
*Saint Helena (UK)	African	7703
*Saint Kitts (St Christopher) I. (UK)	Neotropical	7702
*Saint Lucia	Neotropical	7702
Saint Pierre & Miquelon (France)	Circumboreal	7601
*Saint Vincent	Neotropical	7702
San Marino	Tethyan	7603
San Salvador	Neotropical	7702
Santa Cruz Is (Melanesia)	Fiji-Polyn.	7709
Sao Paulo (Brazil)	Neotropical	7702
*Sao T(h)ome & Principe, Democ. Repub. of	African	7703
*Sarawak	Malesian	7708
Sardinia (Sardenga) (Italy)	Tethyan	7603
*Saudi Arabia	Tethyan	7603
Scilly Is (UK)	Circumboreal	7601
Scott I.	Antarctic	7605
*Senegal, Repub. of	African	7703
*Seychelles	Madagascan	7705
Sicily (Italy)	Tethyan	7603
*Sierra Leone	African	7703
Sikkim (India)	E. Asiatic	7604

Name	Phytogeographic area	Card number
Sinai Peninsula	Tethyan	7603
*Sinapore, Repub. of	Malesian	7708
Snares I. (New Zealand)	Antarctic	7605
Socotra (Yemen, PDR)	African	7703
*Solomon Is (Papua New Guinea)?	Fiji-Polyn.	7709
*Somali Democ. Repub.	African	7703
*South African, Repub. of	African	7703
	Cape	7704
South Georgia Is (UK)	Antarctic	7605
South Orkney Is (UK)	Antarctic	7605
South Sandwich Is (UK)	Antarctic	7605
South Shetland Is (UK)	Antarctic	7605
South West Africa (Namibia)	African	7703
*Spain	Circumboreal	7601,
	Tethyan	7603
Spanish (Western) Sahara	Tethyan	7603
*Spanish Territories of N. Africa	Tethyan	7603
*Spitzbergen (Svalbard) (Norway)	Circumboreal	7601
*Sri Lanka (Ceylon), Repub. of	Indian	7706
Subu Archipelago (Indonesia)	Malesian	7708
Sulawesia (Celebes) (Indonesia)	Malesian	7708
*Sudan, Democ. Repub. of	Tethyan	7603,
	African	7703
Sumatra (Indonesia)	Malesian	7708
Sumba & Sumbawa (Indonesia)	Malesian	7708
*Surinam(e)	Neotropical	7702
Svalbard (Norway)	Circumboreal	7601
Swains I. (USA)	Fiji-Polyn.	7709
*Swaziland	African	7703
*Sweden	Circumboreal	7601
*Switzerland	Circumboreal	7601
Sydney (& Phoenix) Is	Fiji-Polyn.	7709
*Syria, Arab Repub. of	Tethyan	7603
Tahiti I. (France)	Fiji-Polyn.	7709
*Taiwan (Formosa)	E. Asiatic	7604
*Tanzania	African	7703
*Thailand (Siam)	Indochinese	7707
*Tibet	Tethyan	7603
Timor (Indonesia)	Malesian	7708
Tobago	Neotropical	7702
*Togo, Repub. of	African	7703
Tokelau (Union group) Is (New Zealand)	Fiji-Polyn.	7709
*Tonga (Friendly group) Is	Fiji-Polyn.	7709
Tongatapu group Is	Fiji-Polyn.	7709
*Trinidad & Tobago	Neotropical	7702
Trindade I. (Brazil)	Neotropical	7702
*Tristan da Cunha (UK)	Antarctic	7605
*Tunisia	Tethyan	7603
*Turkey	Tethyan	7603
*Turks & Caicos Is (UK)	Neotropical	7702
*Tuvalu (Ellis) Is	Fiji-Polyn.	7709
*Uganda	African	7703
Union group of Is (Tokelau) (New Zealand)	Fiji-Polyn.	7709

Name	Phytogeographic area	Card number
*Union of Soviet Socialist Republics	Circumboreal	7601,
	E. Asiatic	7604,
	Antarctic	7605
*United Arab Emirates	African	7703
*United Kingdom	Circumboreal	7601
*United States of America	Circumboreal	7601,
	Atl. N. Amer.	7602,
	Madrean	7701,
	Neotropical	7702,
*Uruguay	Antarctic	7605
Vanuatu (New Hebrides)	Fiji-Polyn.	7709
Vava'u group Is	Fiji-Polyn.	7709
*Venezuela	Neotropical	7702
Vietnam, North	E. Asiatic	7604,
	Indochinese	7707
Vietnam, South	Indochinese	7707
*Virgin Is (USA & UK)	Neotropical	7702
Volcano (Kazan Retto) Is (Japan)	E. Asiatic	7604
Volta, Upper (Bourkina Fasso)	African	7703
*Wake Is (USA)	Fiji-Polyn.	7709
*Wallis & Futuna Is (W. Samoa) (France)	Fiji-Polyn.	7709
Washington I. (Line Is)	Fiji-Polyn.	7709
West Indian Antilles	Neotropical	7702
Western Sahara (Spanish Sahara)	Tethyan	7603
*Western Samoa Is	Fiji-Polyn.	7709
Windward Is	Neotropical	7702
*Yemen, Arab Repub. of	African	7703
*Yemen (South) PDR	Tethyan	7603,
	African	7703
*Yugoslavia	Tethyan	7603
*Zaire, Repub. of (Kinshasa Congo)	African	7703
*Zambia	African	7703
Zanzibar	African	7703
*Zimbabwe (Rhodesia)	African	7703



Phytogeographical areas (chs 76 & 77) (After Takhtajan, 1969 & 1978)



(Base map: Peters' projection)